Exhibit B

Supplemental Expert Disclosure – Professor Robert Battalio

(January 31, 2024)

The Government hereby supplements the December 8, 2023 notice (the "Initial Battalio Notice") regarding the anticipated testimony of Professor Robert Battalio. As previously disclosed, Professor Battalio is an expert in stock market micro-structure and will generally testify about the effects and significance of Archegos's trading on the markets for its various securities.

This supplemental notice adds further detail to the matters previously described in the Initial Battalio Notice, including by identifying relevant equations and methodologies, reporting model outputs, and providing draft graphs and demonstratives. Except where specifically noted, this supplemental notice does not intend to relinquish any subject or anticipated testimony previously described. This supplemental notice also does not recite Professor Battalio's qualifications, which are described in the initial notice and in his *curriculum vitae* or set out again the terms and concepts that are likely to arise during his testimony. Finally, and at the Court's suggestion, the Government is further providing notice in the form of a 3500 production today that includes intermediate tables, computer code, model outputs, and numerous other sample graphs.

The Government reserves the right to further supplement its notices regarding Professor Battalio's testimony, including in response to the disclosure of any defense micro-market analysis.

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A. Overview

1. As set forth in the Initial Battalio Notice, and as further detailed below, the Government anticipates that, if called, Professor Battalio will testify that Archegos significantly altered the market prices of its top securities during the period of April 2020 through March 23, 2021 and that its trading choices were consistent with a strategy to alter prices of the top securities in its portfolio in Archegos's favor.

2. Professor Battalio's conclusion rests on a variety of data-driven analyses of Archegos's orders and the observable market consequences to those orders. As to price impact, Professor Battalio has deployed a variety of statistical tools to demonstrate that Archegos's trading, in fact, had significant impacts on the prices of the top securities in its portfolio and, in fact, moved the prices of those securities to the benefit of Archegos's portfolio. Professor Battalio compared the performance of Archegos's top securities to the market as a whole and to ETFs for their sectors, a comparison which shows that Archegos's positions outperformed the market when Archegos actively traded them and underperformed the market when Archegos stopped. Professor Battalio also examined how and when Archegos traded. Its order instructions show that Archegos was extraordinarily aggressive by consistently placing larger orders and more expensive orders than other participants in the market. And Professor Battalio conducted regression analysis to conclude that Archegos tended to increase the size and price limits of its orders when stock prices began to recede. Taken together, Archegos's trading cannot be explained by a strategy to build concentrated positions at the best available prices; rather, Archegos's trading is consistent with a trading strategy designed to influence market prices in its favor.

B. Background Topics and Descriptive Statistics

3. As described in the Initial Battalio Notice, Professor Battalio's testimony may include background terms and concepts related to trading and markets in order to present his opinions and findings. The Initial Battalio Notice included the core terms and concepts likely to arise during Professor Battalio's testimony. Professor Battalio's understanding of these background terms and concepts rests on his more than fifteen years of research and teaching in the field of trading and markets, including specific research on market microstructure, as well as his work with the Nasdaq stock exchange.

4. Notable texts and papers in the field that further substantiate Professor Battalio's understanding include:

- Bacidore, Jeffrey M. *Algorithmic Trading: A Practitioner's Guide.* TBG Press, 2020.
- Battalio, Robert, Shane A. Corwin, and Robert Jennings. "Can Brokers Have It All? On the Relation between Make-Take Fees and Limit Order Execution Quality." *The Journal of Finance* 71, no. 5 (2016): 2193-2238.

- Battalio, Robert, Brian Hatch, and M. Saglam. *The Cost of Routing Orders to High Frequency Traders*. Working Paper, available at http://ssrn. com/abstract= 3281324, 2018.
- Battalio, Robert H., and Robert H. Jennings. "Why do Brokers who do not Charge Payment for Order Flow Route Marketable Orders to Wholesalers?." *Available at SSRN 4304124 (2022)*.
- Battalio, Robert H., Robert H. Jennings, Mehmet Saglam, and Jun Wu. "Identifying Market Maker Trades as Retail From TAQ: No Shortage of False Negatives and False Positives." *Available at SSRN 4579159 (2023).*
- Beason, Tyler, and Sunil Wahal. "The Anatomy of Trading Algorithms." *Available at SSRN 3497001 (2020)*.
- Bertsimas, Dimitris, and Andrew W. Lo. "Optimal control of execution costs." *Journal of Financial Markets* 1, no. 1 (1998): 1-50.
- Chakravarty, Sugato. "Stealth-trading: Which traders' trades move stock prices?." *Journal of Financial Economics* 61, no. 2 (2001): 289-307.
- Conrad, Jennifer, and Sunil Wahal. "The term structure of liquidity provision." *Journal of Financial Economics* 136, no. 1 (2020): 239-259.
- Frazzini, Andrea, Ronen Israel, and Tobias J. Moskowitz. "Trading Costs." *Available at SSRN 3229719 (2018)*.
- Griffin, John M., Jeffrey H. Harris, and Selim Topaloglu. "The Dynamics of Institutional and Individual Trading." *The Journal of Finance* 58, no. 6 (2003): 2285-2320.
- Harris, Larry. *Trading and Exchanges: Market Microstructure for Practitioners.* 1st ed. Oxford: Oxford University Press, 2002.
- Lynch, Anthony W., and Richard R. Mendenhall. "New Evidence on Stock Price Effects Associated with Changes in the S&P 500 Index" *The Journal of Business* 70, no. 3 (1997): 351-383.
- Perold, Andre F. "The Implementation Shortfall: Paper Versus Reality" *Journal of Portfolio Management* 14, no. 3 (1988): 4.

5. As described in the Initial Battalio notice, Professor Battalio will explain how American securities exchanges function, what trade and order information is captured by the market itself, what information is broadcast to market participants, and how securities transactions occur within them. Professor Battalio's understanding is based on the general sources identified above, his academic research, his personal experience on the Nasdaq Quality of Markets Committee, and his years of working with various types of stock market data including publicly available information released to market participants and the specific trade-and-quote and order book data obtained in this matter.

6. As described in the Initial Battalio notice, Professor Battalio will provide summary statistics and graphs reflecting the price and trade volume for equities traded under the ticker symbols VIAC, DISCA, DISCK, GSX,[1] IQ, TME, VIPS, BIDU, FTCH, and TCBI (the "Archegos Top Long Positions") and FUTU and RKT (the "Archegos Top Short Positions") (the "Archegos Top Long Positions" and the "Archegos Top Short Positions" are collectively the "Top Archegos Securities") during 2020 and 2021 and at various points and intervals within 2020 and 2021.

7. Professor Battalio's summary statistics and charts regarding Archegos's portfolio and trading rely on the following primary data sources:

- Archegos's trade blotter[2];
- Archegos EMSX data obtained from Bloomberg[3];
- Nasdaq order book data;[4]
- TAQ market-wide trade data;[5]
- NBBO data;[6]
- CRSP shares outstanding (representing number of ADR shares outstanding for ADRs and number of shares outstanding for US stocks, treasury shares not included)[7];
- Bloomberg data for total shares outstanding, cancelled and treasury shares removed by Bloomberg where disclosure allows[8];
- CRSP for prices of the Top Archegos Securities[9];
- CRSP for price of SPY and industry ETFs[10]; and
- Yahoo! Finance exchange rates[11];

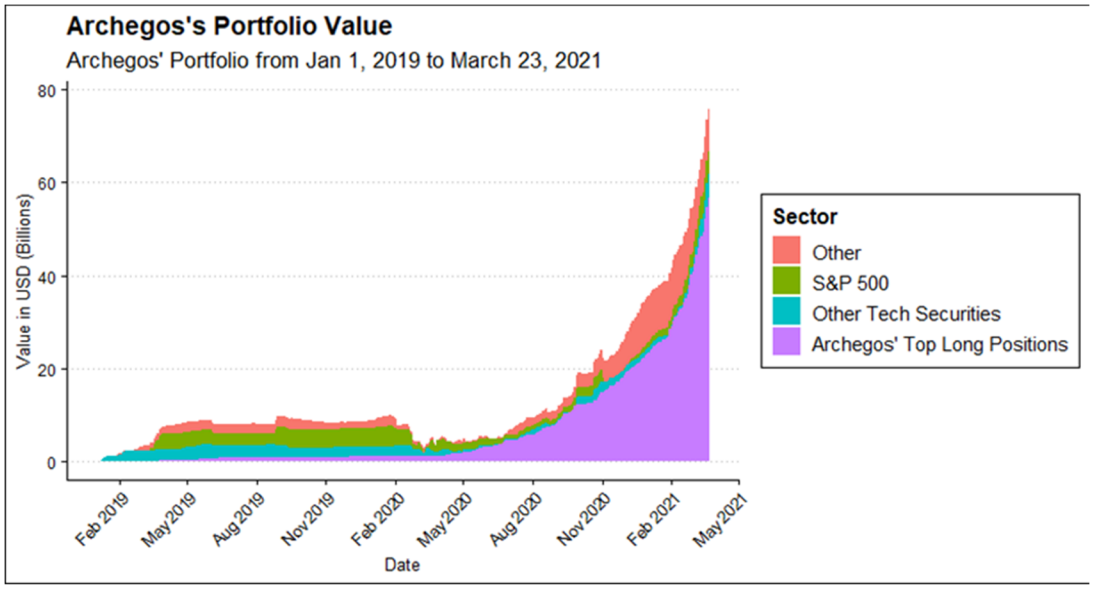
[1] "GSX" is now listed under the symbol "GOTU." Workpapers and draft charts use GSX and GOTU interchangeably.
[2] SDNY_P001_0006141102, originally entitled, SEC-DOJ-EPROD-000000001. Because the trade blotter does not have full and standardized names for each equity, the blotter names were mapped to equity names in an intermediate table.
[3] SDNY_P022_0000000003, originally entitled, Bloomberg - FOIA Confidential Treatment Requested - 21mag9335.csv.
[4] SDNY_001_00000622-00000623.
[5] SDNY_P016_0000000001.
[6] SDNY_P019_0000000001-0000000082.
[7] Crsp_tickers.csv, a subfile of the material produced as SDNY_P016_ 0000010801- 0000010802.
[8] shrsout_comp.csv.
[9] Crsp_tickers.csv, a subfile of the material produced as SDNY_P016_ 0000010801- 0000010802.
[10] Crsp_mkt_industry.csv, a subfile of the material produced as SDNY_P016_ 0000010801-0000010802.
[11] These materials are included in the "Yahoo FX" folder.

As noted, Professor Battalio has used two different data sets to identify shares outstanding—the CRSP data and Bloomberg data. Because of differences in methodologies used to assemble the data, those two datasets report different share counts.[12]

8. Professor Battalio will show that the mark-to-market value of Archegos's portfolio grew significantly between January 2019 and March 2021, with most of that growth occurring after May 2020 and most of the growth attributable to performance and concentration in Archegos's Top Long Positions. Professor Battalio bases this observation on his calculation of the net positions held by Archegos on each date within the range marked to the prevailing securities prices, as reflected in CRSP. For securities not denominated in US dollars, Professor Battalio converted the values to USD using daily foreign exchange rates from Yahoo! Finance on each date.

9. Professor Battalio will present the changes and trends in Archegos's portfolio through tables and graphs. Figure 1, below, plots the value of Archegos's portfolio over time and divides the portfolio into four categories: Archegos Top Long Securities, S&P 500 Index, Other Tech Securities, and Other Securities.

Figure 1 - Archegos Portfolio Value Jan. 1, 2019 to March 23, 2021



10. Using Archegos's trade blotter and information from CRSP and Bloomberg regarding shares outstanding, Professor Battalio will summarize how large Archegos's net positions in the Top Archegos Securities became by March 23, 2021.

[12] For foreign issuers, CRSP reports the total number of ADRs; whereas Bloomberg reports the shares outstanding, which may include both ADRs and shares listed on foreign exchanges.

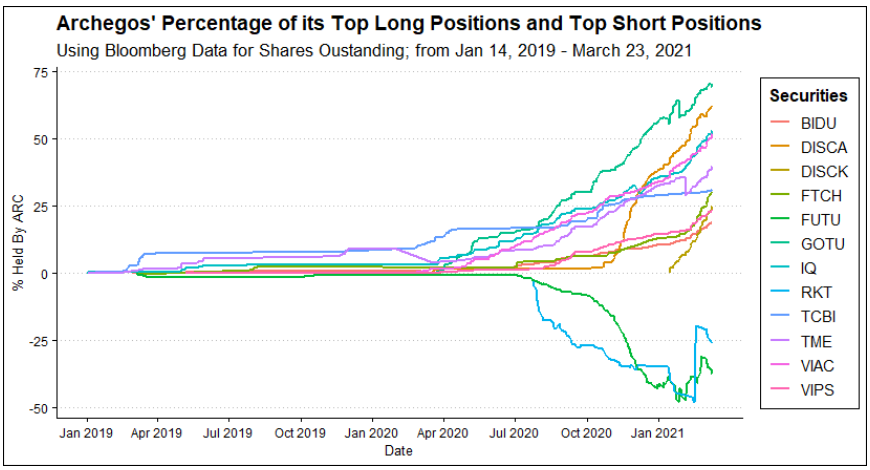
11. Table 1, below, reports summary information regarding Archegos's position sizes and reflects that Archegos's positions, if held in equity, would have translated to significant portions of the outstanding shares issued by each company.

Table 1 - Archegos Position Sizes as Percentage of Shares Outstanding

Ticker	**Archegos Net Position (USD)**	**Archegos Equivalent % of Shares Held (from Bloomberg)**	**Archegos Equivalent % of Shares Held (from CRSP)**
BIDU	10,568,615,964	18.99%	19.42%
DISCA	3,814,628,862	62.62%	62.62%
DISCK	3,864,990,951	24.89%	24.89%
FTCH	4,813,494,817	30.38%	31.91%
FUTU	-1,126,915,468	-37.40%	-38.12%
GOTU	7,050,590,707	69.18%	120.09%
IQ	4,340,006,392	53.02%	55.53%
RKT	-689,690,800	-26.04%	-26.04%
TCBI	690,705,263	31.24%	31.24%
TME	6,440,493,216	39.75%	404.79%
VIAC	12,357,962,908	52.06%	51.86%
VIPS	3,864,896,542	23.77%	31.03%

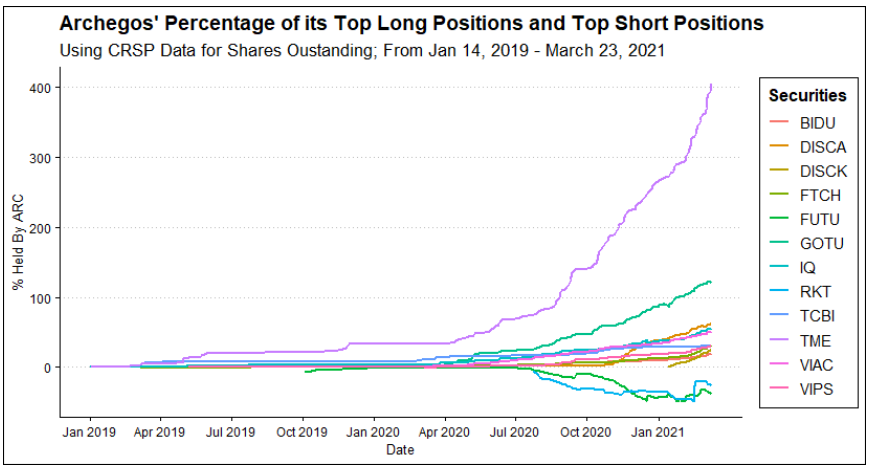
12. Professor Battalio will use the same data sources to plot the increase in Archegos's relative position sizes over time. Figure 2, below, illustrates the growth in Archegos's positions expressed as a percentage of shares outstanding, as derived from a Bloomberg data set.

Figure 2- Archegos Position Size Relative to Shares Outstanding (from Bloomberg)



13. Figure 3, below, illustrates the growth in Archegos's positions expressed as a percentage of shares outstanding, as derived from the CRSP data set.

Figure 3 - Archegos Position Size Relative to Shares Outstanding (from CRSP)



14. Professor Battalio will explain that in 2020 and early 2021 the Archegos Top Securities outperformed the equities market and outperformed other equities in their sector. Professor Battalio bases this conclusion on a comparison between the price returns of the Archegos Top Securities and, alternatively, the price returns of a broad market ETF, such as SPY, and the price returns of sector-specific ETFs, such as VGT. Analysis was done using Python Jupyter notebooks. Net positions are normalized by shares outstanding.

15. Price return refers to the percentage change in price over a specified interval, as follows:

$$R_t = \frac{Price_t - Price_{t-1}}{Price_{t-1}} x\ 100$$

16. Professor Battalio will illustrate Archegos's price return performance as compared to market and sector performance through graphs. Specifically, Professor Battalio will show graphs that plot the cumulative return of individual stocks against the performance of market indexes and ETFs over two periods: the period from October 1, 2020 through June 30, 2021 and a period reflecting the date Archegos's position equated to approximately 5% of shares outstanding through June 20, 2021. For graphs starting on October 1, 2020, cumulative returns through a specific date are calculated as the stock price on the date, minus the stock price on October 1, 2020, divided by the stock price on October 1, 2020. For graphs beginning when Archegos's investment equates to 5% of an issuer's shares outstanding (or -5% for the short positions), cumulative return of individual stocks and the SPY ETF is calculated beginning at the date at which Archegos's position reaches the equivalent of 5% of shares outstanding and is calculated as the price at a given date, minus the price from the start date, divided by the price at the start date.

17. Professor Battalio will compare the price returns of the Top Archegos Securities against the price returns of the following sector- and market-wide ETFs:

- The SPDR S&P 500 ETF Trust ("SPY") seeks to provide investment results that correspond generally to the price and yield performance of the S&P 500 Index.[13]

- The SPDR S&P Regional Banking ETF ("KRE") seeks to provide investment results that correspond generally to the total return performance of the S&P Regional Banks Select Industry Index.[14]

- The Vanguard Information Technology Index Fund ("VGT") is an ETF that seeks to track the performance of a benchmark index that measures the investment return of stock in the information technology sector.[15]

- The Communications Services Select Sector SPDR ("XLC") is an ETF composed of companies primarily involved in modern communication activities and information

[13] SPY Fact Sheet, available at: https://www.ssga.com/library-content/products/factsheets/etfs/us/factsheet-us-en-spy.pdf

[14] KRE Fact Sheet, available at: https://www.ssga.com/library-content/products/factsheets/etfs/us/factsheet-us-en-kre.pdf.

[15] Vanguard VGT product profile, available at: https://investor.vanguard.com/investment-products/etfs/profile/vgt

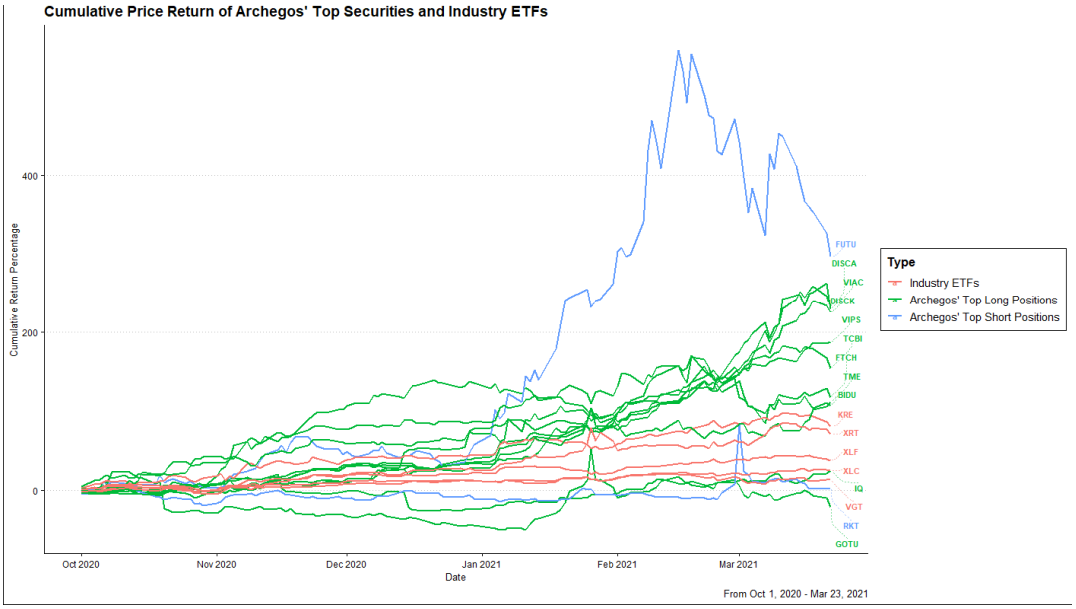
delivery.[16]

- The SPDR S&P Retail ETF ("XRT") is an ETF that seeks to provide investment results that correspond generally to the total return perform of the S&P Retail Select Industry Index.[17]

- The Financial Select Sector SPDR Fund ("XLF") is an ETF that seeks to provide investment results that correspond generally to the price and yield performance of the Finance Select Sector Index.[18]

18. Based on that comparison, Professor Battalio will explain that Archegos's Top Long Positions overperformed the market and overperformed their sectors in the period leading up to March 23, 2021. Figure 4, below, illustrates the trend.

Figure 4 - Archegos Positions Outperform Before March 23, 2021



19. Professor Battalio will also present graphs that illustrate that Archegos's Top Position experienced outsized returns as Archegos's relative position sizes increased.[19] Figure 5 illustrates that Archegos's position size in DISCA corresponded to DISCA price returns that exceeded

[16] XLC Fact Sheet, available at: https://www.sectorspdrs.com/api/documents/by-fullname/Sector%20Documents/XLC%20-%20Communication%20Services%20Documents/Fact%20Sheet.

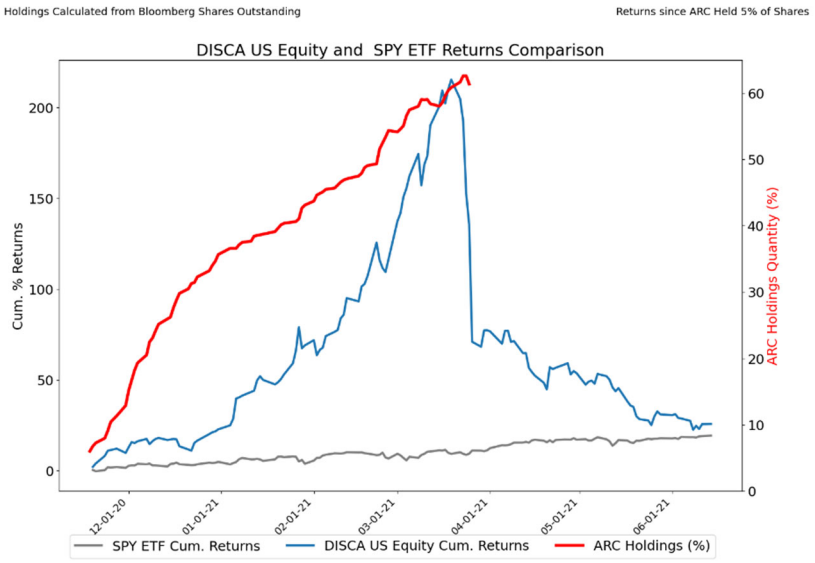
[17] XRT Fact Sheet, available at: https://www.ssga.com/library-content/products/factsheets/etfs/us/factsheet-us-en-xrt.pdf.

[18] XLF Fact Sheet, available at: https://www.ssga.com/library-content/products/factsheets/etfs/us/factsheet-us-en-xlf.pdf.

[19] In addition to the examples included below, further draft graphs will be produced.

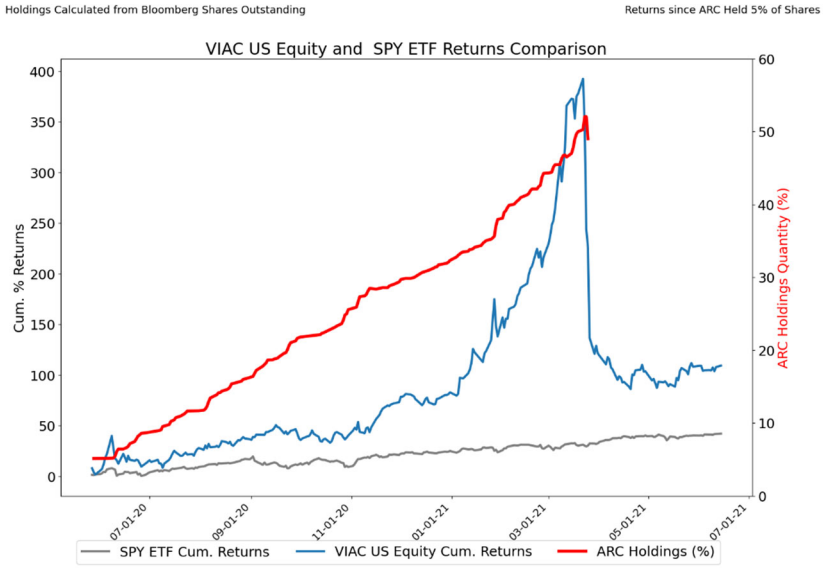
market-wide returns, as measured by SPY.

Figure 5 - Archegos DISCA Position and Performance Relative to SPY



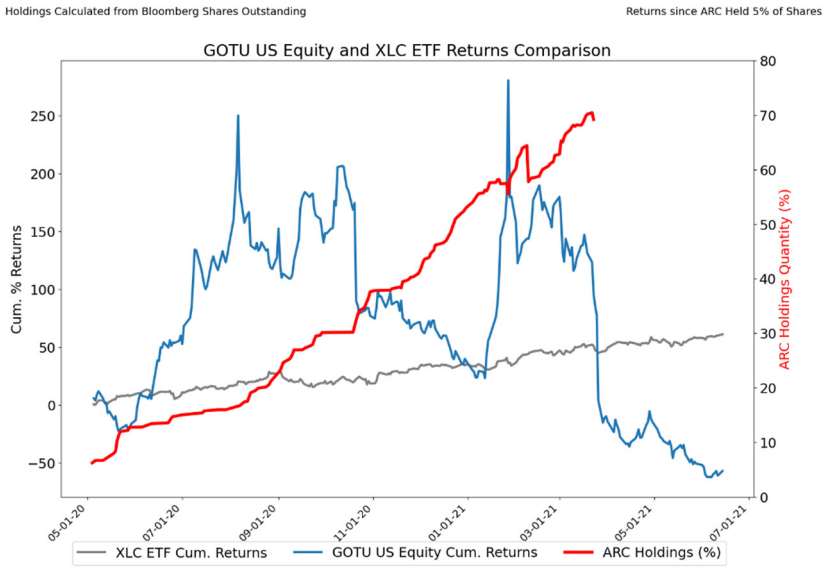
20. Figure 6 illustrates that Archegos's position size in VIAC corresponded to VIAC price returns that exceeded market-wide returns, as measured by SPY.

Figure 6 - Archegos VIAC Position and Performance Relative to SPY



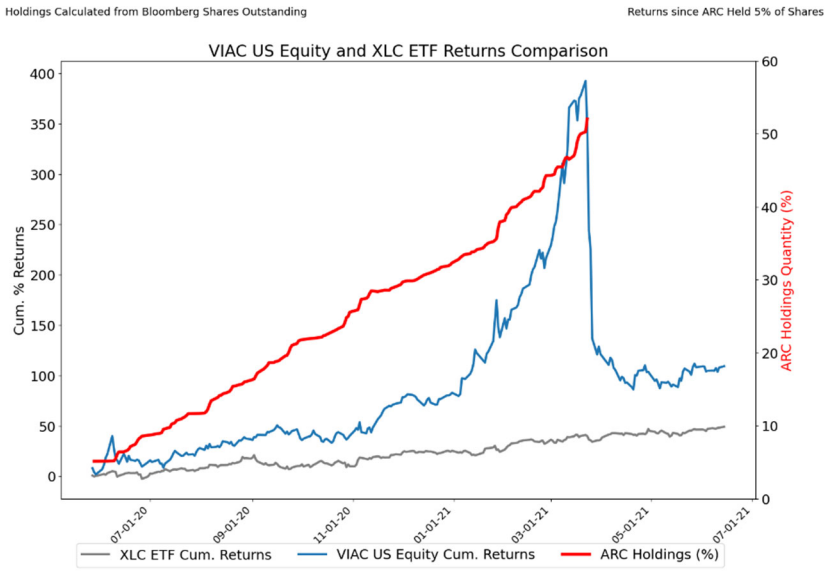
21. Figure 7 illustrates that Archegos's position size in GSX corresponded to GSX price returns that exceeded sector returns, as measured by the XLC ETF.

Figure 7 - Archegos GSX (GOTU) Position and Performance Relative to XLC



22. Figure 8 illustrates that Archegos's position size in VIAC corresponded to VIAC price returns that exceeded sector returns, as measured by the XLC ETF.

Figure 8 - Archegos VIAC Position and Performance Relative to XLC



23. Professor Battalio also reviewed the price return of Archegos's Top Positions after Archegos stopped enlarging its positions. Based on comparison between the price returns of those positions and the price returns of the market and sector ETFs identified above, Professor Battalio

will explain that Archegos's Top Long Positions underperformed the market and underperformed their sectors in the period following March 23, 2021.

24. Professor Battalio has calculated the price return of Archegos's Top Positions and market wide and sector ETF, as reflected in the CRSP data, for the period March 23, 2021 through June 23, 2021. Table 2, below, reports the results.

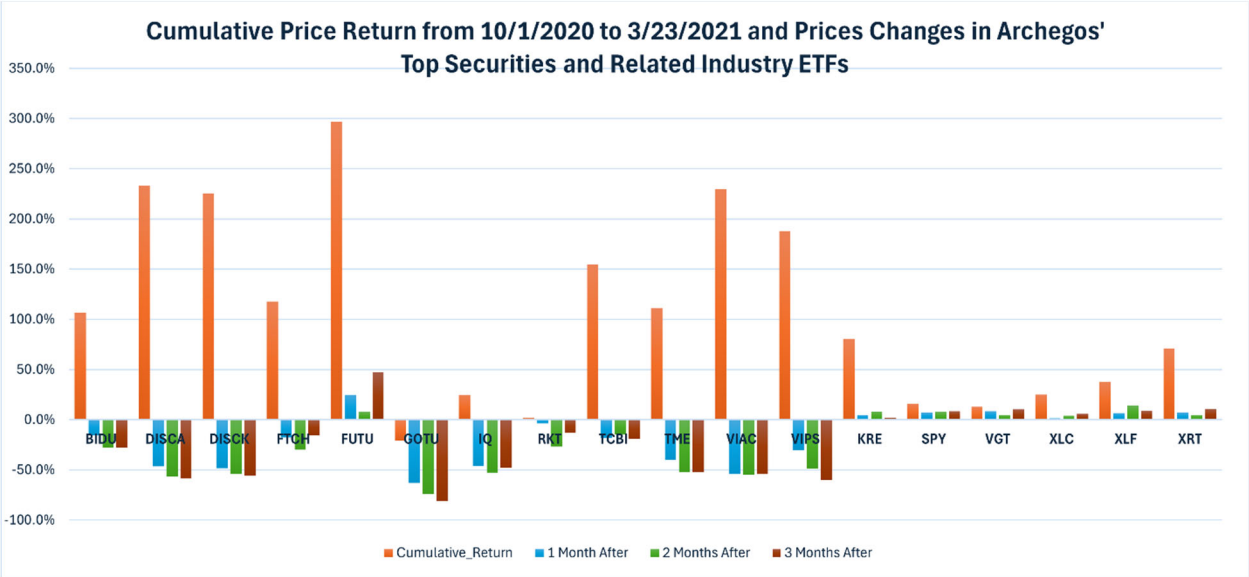
Table 2 - Price Returns After Archegos Stops Buying

Security	**Cumulative Return**	**1 Month After**	**2 Months After**	**3 Months After**
BIDU	106.80%	-15.50%	-27.80%	-27.70%
DISCA	233.20%	-46.40%	-56.40%	-58.80%
DISCK	225.40%	-48.50%	-54.20%	-55.90%
FTCH	117.50%	-17.70%	-29.90%	-15.70%
FUTU	297.20%	24.80%	7.70%	47.20%
GOTU	-21.20%	-63.10%	-74.10%	-81.00%
IQ	24.70%	-46.00%	-52.90%	-47.90%
RKT	1.70%	-3.90%	-26.70%	-13.10%
TCBI	154.40%	-18.30%	-14.40%	-19.20%
TME	111.40%	-40.30%	-52.00%	-52.10%
VIAC	229.70%	-54.30%	-54.50%	-54.20%
VIPS	187.60%	-30.30%	-48.60%	-60.30%
KRE	80.30%	4.80%	8.20%	1.70%
SPY	15.60%	7.00%	7.60%	8.50%
VGT	12.70%	8.40%	4.70%	10.10%
XLC	25.10%	1.50%	3.90%	5.90%
XLF	37.50%	6.70%	13.90%	8.70%
XRT	71.00%	7.00%	4.80%	10.40%

The Cumulative Return column reports the return from the period October 1, 2021 to March 23, 2021. Based on this price return data, Professor Battalio will show that the prices of the Top Long Positions substantially declined after Archegos stopped purchasing them and that the prices remained down through June 23, 2021.

25. The same results can be presented visually, as reflected in Figure 9.

Figure 9 - Performance After March 23, 2021 Compared



26. Based on this analysis, and as set forth in the Initial Battalio Notice, Professor Battalio will observe that in 2020 and early 2021, Archegos increased its holdings of VIAC, DISCA, DISCK, GX, IQ, TME, VIPS, FTCH, FUTU, RKT, BIDU, and TCBI; Archegos's positions grew increasingly large in market value and size relative to shares outstanding; Archegos's buying coincided with outperforming price returns; and the cessation of Archegos's buying coincided with underperforming price returns.

C. Trade Mapping

1. Overview

27. As set forth in the Initial Battalio Notice, Professor Battalio will opine that Archegos's trade orders in swaps can be linked to specific equity transactions in the National Market System. Professor Battalio's opinion rests on his understanding of market mechanics, a review of Archegos's EMSX order records, and the results of two trade-mapping studies—one that matches Archegos orders to Nasdaq execution data and another that matches Archegos orders to market wide TAQ data. Additionally, based on his trade mapping studies, Professor Battalio will opine that the file "nasdaq_with_match_v1.fst" represents a conservative sample of Archegos-linked executions in Nasdaq and the file "taq_with_match_v5.fst" represents a conservative sample of Archegos-linked executions found in the Daily TAQ data.

2. Scope and Sources

28. Order information from EMSX records can be matched to Nasdaq order book data or,

alternatively, to TAQ data.[20] Professor Battalio mapped trades from Jan 2, 2020 to April 21, 2021 for the Nasdaq order book matching and from Jan 2, 2020 to Mar 31, 2021 for the TAQ matching.

3. Methodology

29. The matching process occurs in multiple steps with the assistance of a computer program written in the programming language "R."[21] The matching process aims to associate specific transactions reflected in the EMSX data—including time, quantity, and price—to equity execution data reflected in Nasdaq and TAQ.

30. For Nasdaq matching, the relevant EMSX data fields used to identify matches include:

- timestamp
- fill quantity
- execution price
- ticker
- exchange
- buysell (i.e., whether a trade was buyer or seller initiated)

Professor Battalio mapped the exchange codes reflected in the Archegos EMSX data to the exchange codes in the Nasdaq data. Matches are first performed using the exchange mapping, then followed by matches without the exchange mapping for records that did not have the exchange mapped.

The matching process cumulatively identifies matches using specific matching parameters. The analysis begins with time precision of 1 millisecond, increasing to 10 seconds, using in the following intervals:

- 1 millisecond
- 1/100th of a second
- 1/10th of a second
- 1 second
- 3 seconds
- 10 seconds

The analysis groups the matches into different types based:

- 1:1 matches only. For 1:1 matches there had to be the same number of records in the EMSX data and Nasdaq data for a specific combination of timestamp, fill quantity,

[20] The relevant EMSX data is the "route view" file bearing Bates number SDNY_P022_0000000003. The relevant Nasdaq data bears the Bates number SDNY_001_00000622-00000623. The relevant TAQ data bears the Bates number SDNY_P016_0000000001.

[21] The Government has provided the defense with the R code used to conduct the Nasdaq trade matching and, separately, the R code used to conduct the TAQ trade matching.

execution price, ticker, buysell and, when used, exchange. For example, if a specific combination of fields occurred 2 times in the EMSX data but 3 times in the Nasdaq data this was not counted as a 1:1 match.

- Multiple EMSX records sum up to one Nasdaq trade. This allowed for matches where the sum of the fill quantity in the EMSX data matched the fill quantity in a trade from the Nasdaq data. So, for example, if a specific combination of timestamp, execution price, ticker and buysell occurred 2 times in the ARC Bloomberg data with fill quantities of 10 and 20 and occurred 1 time in the Nasdaq data with a fill quantity of 30 then this would be considered a match.
- Matches using the closest time. For example, if a specific combination of fields occurred 1 time in the EMSX data but 2 times in the Nasdaq data the 1 record in the EMSX data would have been matched to the record with the closest timestamp in the Nasdaq data.

For TAQ matching, the relevant EMSX data fields used to identify matches include:

- timestamp
- fill quantity
- execution price
- ticker
- exchange

Professor Battalio constructed a mapping between exchanges in the EMSX data to the exchange codes in the TAQ data. For the TAQ data, the analysis uses 4 different types of exchange mapping:

- Single exchange mapping. This was for exchanges in the EMSX data that could only go to a single exchange code in the TAQ data.
- Dual exchange mapping. Some exchanges in the EMSX data could match with 2 exchange codes in the Daily TAQ data.
- Trade reporting facility matches (TRF). For some exchanges in the EMSX data, trades were matched only with records in the Daily TAQ data which had a non-missing value in the trade reporting facility field.
- Any exchange mapping. There were a few exchanges in the EMSX data that were allowed to match with any exchange in the Daily TAQ data.

As with the Nasdaq matching process, the TAQ matching process cumulatively identified matches using specific parameters. The analysis begins with time precision of 1 millisecond, increasing to 10 seconds, using in the following intervals:

- 1 millisecond
- $1/100^{th}$ of a second
- $1/10^{th}$ of a second
- 1 second
- 3 seconds
- 10 seconds

The analysis groups the matches into different types based:

- 1:1 matches only. For 1:1 matches there had to be the same number of records in the EMSX data and TAQ data for a specific combination of timestamp, fill quantity, execution price, ticker and exchange. For example, if a specific combination of fields occurred 1 time in the EMSX data but 2 times in the Daily TAQ data this was not counted as a 1:1 match.
- Multiple EMSX records sum up to one Daily TAQ trade. This allowed for matches where the sum of the fill quantity in the EMSX data matched the fill quantity in a trade from the Daily TAQ data. So, for example, if a specific combination of timestamp, execution price and ticker occurred 2 times in the ARC Bloomberg data with fill quantities of 10 and 20 and occurred 1 time in the Daily TAQ data with a fill quantity of 30 then this would be considered a match. These types of matches were only considered for lit exchanges (that is, these matches excluded dark pools).
- Matches using the closest time. For example, if a specific combination of fields occurred 1 time in the EMSX data but 2 times in the Daily TAQ data the 1 record in the EMSX data would have been matched to the record with the closest timestamp in the Daily TAQ data.

4. Results

31. The trades matched from EMSX records to Nasdaq execution data are included in the file, "Nasdaq_with_match_v1.fst."

32. Table 3, below, reports the number of matches found under each parameter and cumulatively under all parameters. As set forth below, approximately 97% of the trades represented within Archegos's EMSX data can be matched to Nasdaq executions. Table 4 excludes the exchange labeled "MSCS" because MSCS records route to all exchanges, not just Nasdaq. Including "MSCS" trades drops the match percentage to 76.5% because many of those trades went to other exchanges.

Table 3 - Nasdaq Matching by Parameter

Type of match	Time precision used	Exchange mapped?	Number of matches from ARC Bloomberg	% matched from ARC Bloomberg	Cumulative % matched from Bloomberg	Cumulative % excluding MSCS
1:1 matches only	Millisecond	Yes	220,370	12.2%	12.2%	22.9%
	Millisecond	No	128,238	7.1%	19.3%	22.9%
	1/100th second	Yes	106,922	5.9%	25.3%	34.1%
	1/100th second	No	66,954	3.7%	29.0%	34.1%
	1/10th second	Yes	143,500	8.0%	36.9%	49.0%
	1/10th second	No	66,223	3.7%	40.6%	49.1%
	1 second	Yes	156,099	8.7%	49.3%	65.3%
	1 second	No	8,730	0.5%	49.7%	65.7%
	3 seconds	Yes	83,908	4.7%	54.4%	74.4%
	3 seconds	No	10,346	0.6%	55.0%	74.6%
	10 seconds	Yes	39,740	2.2%	57.2%	78.8%

	10 seconds	No	9,681	0.5%	57.7%	78.9%
Multiple ARC Bloomberg trades sum up to one Nasdaq trade	Millisecond	Yes	499	0.0%	57.7%	79.0%
	Millisecond	No	1,260	0.1%	57.8%	79.0%
	1/100th second	Yes	486	0.0%	57.8%	79.0%
	1/100th second	No	752	0.0%	57.9%	79.0%
	1/10th second	Yes	923	0.1%	57.9%	79.1%
	1/10th second	No	1,114	0.1%	58.0%	79.1%
	1 second	Yes	1,793	0.1%	58.1%	79.3%
	1 second	No	667	0.0%	58.1%	79.3%
	3 seconds	Yes	1,564	0.1%	58.2%	79.5%
	3 seconds	No	702	0.0%	58.3%	79.5%
	10 seconds	Yes	1,904	0.1%	58.4%	79.7%
	10 seconds	No	1,003	0.1%	58.4%	79.7%
Closest time matches	Millisecond	Yes	20,438	1.1%	59.6%	81.8%
	Millisecond	No	71,961	4.0%	63.5%	81.8%
	1/100th second	Yes	13,763	0.8%	64.3%	83.3%
	1/100th second	No	30,617	1.7%	66.0%	83.3%
	1/10th second	Yes	26,302	1.5%	67.5%	86.0%
	1/10th second	No	32,162	1.8%	69.2%	86.0%
	1 second	Yes	56,580	3.1%	72.4%	91.9%
	1 second	No	7,204	0.4%	72.8%	92.0%
	3 seconds	Yes	30,554	1.7%	74.5%	95.2%
	3 seconds	No	8,975	0.5%	75.0%	95.3%
	10 seconds	Yes	16,670	0.9%	75.9%	97.0%
	10 seconds	No	11,522	0.6%	76.5%	97.1%

33. The set of identified matches between Archegos's order records and TAQ execution data is the file named, "taq_with_match_v5.fst."

34. Table 4, below, reports the number of matches found under each parameter and cumulatively under all parameters. As set forth below, approximately 89% of the trades represented within Archegos's EMSX data can be matched to TAQ executions.

Table 4 - Daily TAQ Matches by Parameter

Type of match	Time precision used	Exchange mapping	Number of matches from ARC Bloomberg	% matched from ARC Bloomberg	Cumulative % matched from ARC Bloomberg
1:1 matches only	Millisecond	Single	253,593	2.93%	2.93%
		Dual	337,498	3.90%	6.83%
		TRF	31,026	0.36%	7.19%
		Any	352,641	4.07%	11.26%
	1/100th second	Single	321,661	3.72%	14.97%
		Dual	293,278	3.39%	18.36%
		TRF	244,572	2.82%	21.19%
		Any	393,269	4.54%	25.73%
	1/10th second	Single	443,467	5.12%	30.85%
		Dual	397,762	4.59%	35.44%
		TRF	638,240	7.37%	42.81%
		Any	459,832	5.31%	48.13%
	1 second	Single	340,465	3.93%	52.06%
		Dual	360,891	4.17%	56.23%
		TRF	291,879	3.37%	59.60%

		Any	22,043	0.25%	59.85%
	3 seconds	Single	192,869	2.23%	62.08%
		Dual	192,629	2.22%	64.30%
		TRF	290,137	3.35%	67.66%
		Any	25,118	0.29%	67.95%
	10 seconds	Single	99,431	1.15%	69.09%
		Dual	92,736	1.07%	70.16%
		TRF	123,833	1.43%	71.60%
		Any	10,177	0.12%	71.71%
Multiple ARC Bloomberg trades sum up to one TAQ trade	Millisecond	Single	39,923	0.46%	72.17%
		Dual	825	0.01%	72.18%
		TRF	40	0.00%	72.18%
		Any	13,105	0.15%	72.33%
	1/100th second	Single	30,001	0.35%	72.68%
		Dual	1,059	0.01%	72.69%
		TRF	115	0.00%	72.70%
		Any	7,875	0.09%	72.79%
	1/10th second	Single	42,256	0.49%	73.27%
		Dual	2,096	0.02%	73.30%
		TRF	606	0.01%	73.31%
		Any	8,389	0.10%	73.40%
	1 second	Single	48,758	0.56%	73.97%
		Dual	3,687	0.04%	74.01%
		TRF	1,040	0.01%	74.02%
		Any	2,001	0.02%	74.04%
	3 seconds	Single	23,900	0.28%	74.32%
		Dual	3,051	0.04%	74.35%
		TRF	1,558	0.02%	74.37%
		Any	2,723	0.03%	74.40%
	10 seconds	Single	12,844	0.15%	74.55%
		Dual	3,649	0.04%	74.59%
		TRF	2,041	0.02%	74.62%
		Any	3,592	0.04%	74.66%
Closest time matches	Millisecond	Single	9,926	0.11%	74.77%
		Dual	33,964	0.39%	75.17%
		TRF	4,675	0.05%	75.22%
		Any	195,430	2.26%	77.48%
	1/100th second	Single	16,715	0.19%	77.67%
		Dual	37,406	0.43%	78.10%
		TRF	19,648	0.23%	78.33%
		Any	132,859	1.53%	79.86%
	1/10th second	Single	31,521	0.36%	80.23%
		Dual	71,399	0.82%	81.05%
		TRF	58,112	0.67%	81.72%
		Any	149,318	1.72%	83.45%
	1 second	Single	54,777	0.63%	84.08%
		Dual	123,159	1.42%	85.50%
		TRF	69,528	0.80%	86.31%
		Any	7,808	0.09%	86.40%
	3 seconds	Single	29,542	0.34%	86.74%
		Dual	66,578	0.77%	87.51%
		TRF	52,597	0.61%	88.11%
		Any	7,959	0.09%	88.21%

	10 seconds	Single	19,247	0.22%	88.43%
		Dual	36,748	0.42%	88.85%
		TRF	37,125	0.43%	89.28%
		Any	5,051	0.06%	89.34%

D. Determining Minute-Level Midpoint Prices

35. As described in the Initial Battalio Notice, and as set forth more fully below, Professor Battalio identified minute-level price changes from the NBBO data for use in various analyses. Professor Battalio identified minute-level price midpoints as follows: For each minute, the last occurring record was retrieved to calculate a closing price. For example, if at 10:01 there were 3 prices, one at 10:01:03, another at 10:01:40 and another at 10:01:59, then the price at 10:01:59 was used. The midpoint price was calculated as:

$$\frac{Best\ Bid + Best\ Ask}{2}$$

The program used to facilitate this identification is in R. Result of analysis is a file titled "closing_midpoint_price_by_minute", which could be in a .fst file or a .csv file.

E. Price impact studies

36. As described in the Initial Battalio Notice, Professor Battalio will opine that Archegos-linked trading altered the prevailing market prices of the Archegos Top Long Positions on national securities markets on multiple days between March 2020 and March 2021 and consistently between October 2020 and March 2021. Professor Battalio's opinion rests on his interpretation of the studies described below. Further, and as described in the Initial Battalio Notice, Professor Battalio's understanding rests on academic research into the effects of buy-sell imbalances, such as that illustrated by Lynch and Mendenhall in "New evidence on stock price effects associated with changes in the S&P 500 index." *The Journal of Business* 70, no. 3 (1997): 351-383 at 353-354.

1. Vector Auto Regression Analysis

i. Overview

37. Professor Battalio will present a vector auto regression ("VAR") analysis that demonstrates the statistical relationship between Archegos's trading imbalance in the Archegos Top Long Positions and changes in prevailing stock prices underlying Archegos Top Long Positions. Professor Battalio's VAR analysis will regress price changes at the 1-minute level on Archegos's contemporaneous and lagged trade imbalance, as well as lagged prices.[22] Professor Battalio's VAR analysis shows that Archegos's buy order activity in a given minute often led to a subsequent price increase in the security—that is, for Archegos's Top Long Positions the prices of the securities

[22] *See, for example*, Griffin, John M., Jeffrey H. Harris, and Selim Topaloglu. "The dynamics of institutional and individual trading." *The Journal of Finance* 58, no. 6 (2003): 2285-2320.

correlate to Archegos's trade activity.

ii. Scope & Sources

38. Professor Battalio's VAR analysis primarily rests on Archegos order records from the Bloomberg EMSX data and market transaction information reflected in market-wide TAQ data. The VAR model can be run over any time period for which data exists. Professor Battalio will present results from two time periods: (a) October 1, 2020 through March 23, 2021 and (b) the later of April 1, 2020 and date on which Archegos's position reached a size equal to 5% shares outstanding through March 23, 2021.[23] Archegos buys and sells come from the Archegos EMSX order and execution records maintained by Bloomberg. Market-wide buys and sells were calculated for each minute from the TAQ market-wide trade data.[24] Prices were calculated for each minute from the TAQ NBBO data.[25]

iii. Methodology

39. Professor Battalio's VAR will measure the minute-level returns based on Archegos's contemporaneous minute-level trade imbalance. Programming and statistical languages including Python and STATA were used for this analysis.

40. For each security, the VAR is estimated using five 1-minute lags for both returns and imbalances in the following system of equations.

$$R_t = \beta_1 I_t + \beta_2 I_{t-1} + \beta_3 I_{t-2} + \beta_4 I_{t-3} + \beta_5 I_{t-4} + \beta_6 I_{t-5} + \beta_7 R_{t-1} + \beta_8 R_{t-2} + \beta_9 R_{t-3} + \beta_{10} R_{t-4} + \beta_{11} R_{t-5} + \varepsilon_{t,R}$$

$$I_t = \beta_1 R_t + \beta_2 R_{t-1} + \beta_3 R_{t-2} + \beta_4 R_{t-3} + \beta_5 R_{t-4} + \beta_6 R_{t-5} + \beta_7 I_{t-1} + \beta_8 I_{t-2} + \beta_9 I_{t-3} + \beta_{10} I_{t-4} + \beta_{11} I_{t-5} + \varepsilon_{t,I}$$

The Return (R_t) is defined as the contemporaneous return for each 1-minute trading interval, expressed as a percentage by multiplying by 100. Price is measured by the NBBO midpoint calculated from the TAQ NBBO data. The source for this is the market-wide TAQ data, which was used to generate a minute-level pricing file.

$$R_t = \frac{Price_t - Price_{t-1}}{Price_{t-1}} x\ 100$$

41. The Imbalance (I_t) is measured as the Archegos net buys, which means the Archegos buys minus the Archegos sells (including short sells) in a given minute, divided by the previous day's market-wide trade volume, quantified as buyer-initiated transactions plus seller-initiated

[23] For this analysis, Professor Battalio used the Bloomberg measure of shares outstanding.
[24] This work is reflected in the intermediate table, "volume_by_minute."
[25] This work is reflected in the intermediate table, closing_midpoint_price_by_minute.csv."

transactions (in other words, market-wide buys plus market-wide sells).

$$I_t = \frac{NetBuys_t}{Prior\ Day's\ Marketwide\ Trade\ Volume} x\ 100$$

iv. Results

42. All results of the VAR analysis are reported in the file, VAR Table.xlsx. Based on the results, Professor Battalio will opine that Archegos's order activity led to price increases for the Archegos Top Long Positions.

43. Table 5, below, illustrates regression estimates for the effect of imbalance on stock returns including five time-lagged variables. Newey-West standard errors are used to account for autocorrelation and heteroskedasticity. The complete results are reported in the "reg1," "reg2," "reg3," and "reg4" Word files.

Table 5 - The Effect of Imbalance on Stock Price Returns

	ALL	**VIAC**	**DISCA**	**DISCK**	**BIDU**	**FTCH**	**GSX**	**IQ**	**TCBI**	**TME**	**VIPS**	**VIAC-VIACA**	**DISCA-DISCK**
A: Window from October 1, 2020 through March 23, 2021													
Imbalance	0.02***	0.04**	0.01	0.02**	0.02	0.03	0.02	0.04***	0.00	0.04***	0.04***	0.21	0.03***
t-Stat	(6.01)	(2.29)	(1.19)	(2.16)	(1.22)	(1.51)	(1.52)	(4.99)	(0.63)	(4.93)	(4.02)	(1.54)	(3.97)
B: Window starts with the latter of (a) the date that Archegos's position corresponds to 5% of shares outstanding or (b) April 1, 2020, and extends through March 23, 2021													
Imbalance	0.02***	0.03***	0.01	0.02**	0.03**	0.02	0.01	0.03***	0.01	0.04***	0.05***	0.23**	0.03***
t-Stat	(5.20)	(2.79)	(1.26)	(2.08)	(2.10)	(1.10)	(0.89)	(4.81)	(1.14)	(5.86)	(6.17)	(2.21)	(3.75)

These results demonstrate that Archegos's buying 1% of the Imbalance variable leads to price increase of 0.02% during the study periods for the Archegos Top Long Positions. Professor Battalio will opine that these results demonstrate that Archegos's trading activity had a statistically significant effect on the price of the Archegos Top Long Positions.

44. Professor Battalio will further use the VAR to estimate the impulse response function, which measures the effect of an increase in imbalance (impulse) on contemporaneous and

subsequent price returns (response).[26] The size of the shock from the impulse is 1 standard deviation. The cumulative effect of this impulse is graphed over 10 minutes with a 95 percent confidence interval shaded through light grey with the left axis measured in percentage terms. So, for a 1 standard deviation shock to the imbalance, the return for "VIAC" increased roughly 0.01 percent.

45. Example outputs for VIAC, BIDU, and TCBI are presented below.

Figure 10 - Impulse Response for VIAC

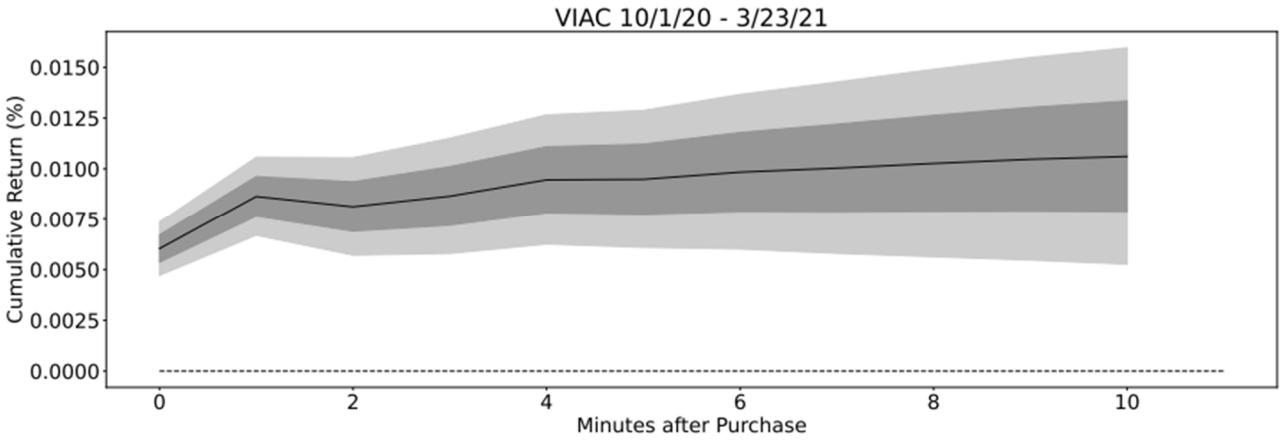
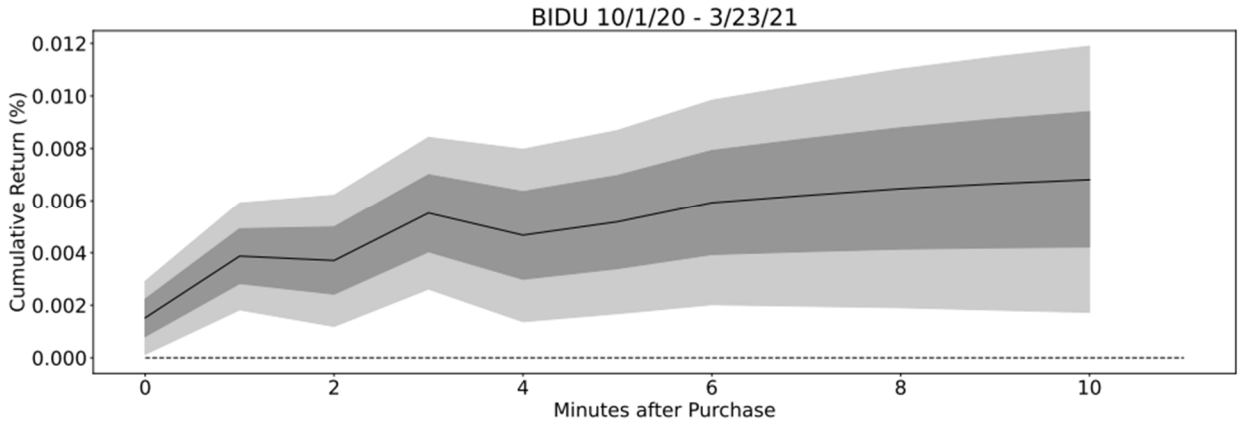
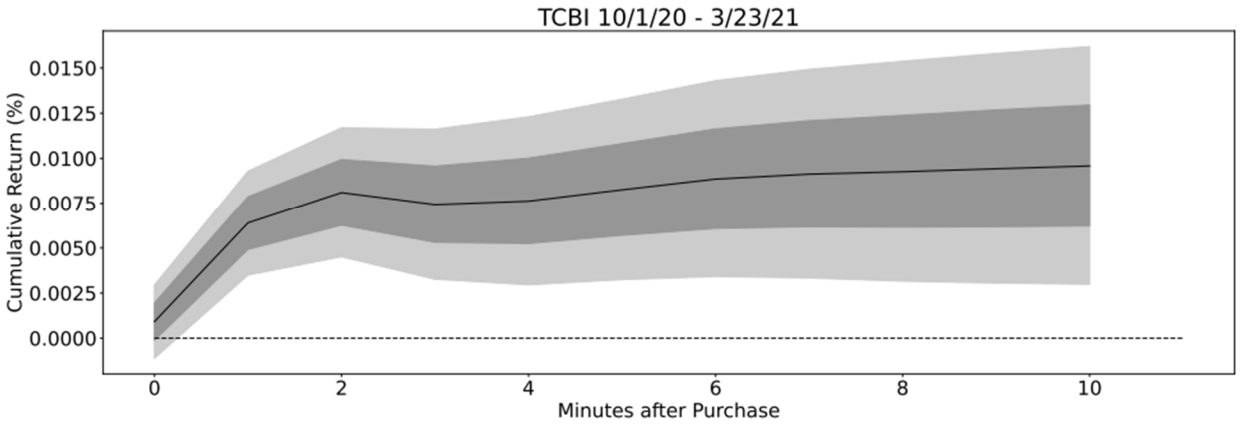


Figure 11 - Impulse Response for BIDU



[26] The code used to generate the impulse response function and the outputs are included in the files 3_Analyze_VAR_Final_01302024.do and 4_VAR_Graphs_Final_01302024.ipynb.

Figure 12 - Impulse Response for TCBI



46. The impulse response function graphs illustrate that for a 1-standard-deviation impulse in the imbalance variable leads to a statistically significant change in price over the next 10-minute period. Additional graphs from the period October 1, 2020 through March 23, 2021 can be found in the PDF etitled "VAR_Final_01302024.pdf". Graphs for the period starting at the later of April 1, 2020 and the date at which Archegos held 5% of a given security can be found in the PDF entitled "VAR_Final_01302024_5pct.pdf.

2. Midpoint Analysis

i. Overview

47. As described in the Initial Battalio Notice, Professor Battalio will opine that Archegos's order activity consistently and significantly altered the midpoint of the bid-ask spread for the Archegos Top Long Positions between October 2020 and March 2021. Put simply, Archegos's trading repeatedly and significantly resulted in upward price-pressure on its Top Long Securities and Archegos, through its trading, caused the prices of those securities to rise.

48. To demonstrate Archegos's market-moving power, Professor Battalio will present three univariate measures of Archegos's influence over market prices: price contribution, price impact, and realized spread. Professor Battalio's primary analysis of the Archegos Top Long Positions will focus on the entire American stock market as represented by the Daily TAQ data and NBBO data.[27] Professor Battalio also conducted a similar analysis looking specifically at price changes on

[27] In this respect, the Government narrows the anticipated scope of Professor Battalio's testimony. In the Initial Battalio Notice, the Government indicated that it would present price impact analysis for two exchanges, NYSE and Nasdaq, in addition to price impact analysis for the market as whole. To avoid unnecessary repetition, the Government no longer intends to present NYSE-specific analysis. If asked, however, the Government anticipates that Professor Battalio would testify that the same results for Nasdaq and the market as whole would be true of NYSE based on the nature of National Market System best execution rules.

Nasdaq, which confirms and bolsters the conclusion of the market-wide, analysis.

49. Professor Battalio will explain that price contribution, price impact, and realized spread capture three different aspects of market function. Price contribution quantifies the aggregated midpoint changes at different time horizons compared to the prevailing midpoint at time of trade. Price impact quantifies the impact on prevailing market prices of the trade over different horizons. Realized spread quantifies the profitability to liquidity providers for trading against Archegos, and accounts for the fact that individual trades can alter exchange order books.

ii. Scope & Sources – Primary Approach

50. Professor Battalio's midpoint price analysis relates to the Archegos Top Long positions during the period April 1, 2020 through and including March 23, 2021. The analysis uses Daily TAQ data, the Archegos-linked trades matched to the Daily TAQ data, and National Best Bid and Offer data. In particular, the NBBO data is used to identify prevailing midpoint prices at various time horizons after a given trade.

iii. Methodology – Primary Approach

51. Professor Battalio's midpoint price analysis computes three primary market impact measures by comparing "active" Archegos trades to trades from all other market participants during business hours over varying trading time horizons, from April 1, 2020 to March 23, 2021. These three measures are: price contribution, price impact, and realized spread, and the time horizons are a tenth of a second, one second, ten seconds, a minute, and five minutes. Professor Battalio's analysis was completed through computer code written in R.[28]

52. Professor Battalio identified "active" Archegos trades by classifying each trade as either buyer- or seller-initiated based on a "quote test" and subsequent "tick test." In the quote test, trades that executed closer (but less than or equal) to the ask than the bid are typed to be buyer-initiated; trades that executed closer (but greater than or equal) to the bid than the ask are typed to be seller-initiated. For trades that cannot be typed with the "quote test," a given trade is typed by a tick test that compares its price against that of the trade that occurred three trades before. A higher price is typed as buyer-initiated; a lower price seller-initiated.

53. The price contribution computation does not use trade typing beyond what is necessary to determine Archegos active trades, whereas price impact and realized spread do. Price contribution uses all days in the time span, whereas price impact and realized spread computations use only days where Archegos is trading in the market for that ticker.

54. Reported price contribution is calculated as the sum of the individual trade price contributions (midpoint changes) over the varying time horizons across trades, divided by number of shares filled (scaled by a multiplier of 10,000). That is, for a given trade at time t in stock j with

[28] The R code used to perform the analysis is in the file nbbo_analyses.R.

time horizon τ, its price contribution is:

$$pc_{jt\tau} = m_{j,t+\tau} - m_{jt}$$

Where m_{jt} is the prevailing midpoint and $m_{j,t+\tau}$ is the midpoint at time τ after the trade.

55. Reported price impact is calculated as the average daily median trade-level price impact in basis points, for days where Archegos is trading. The median is weighted by fill quantity. For a given trade and time horizon, the price impact is a directional quantity multiplied against the horizon midpoint minus the prevailing midpoint at time of trade, divided by the prevailing midpoint at time of trade. For buyer-initiated trades, this directional quantity is +1. For seller-initiated trades, this directional quantity is -1. That is, for a given trade at time *t* in stock *j* with time horizon τ, its price impact is:

$$pi_{jt\tau} = q_{jt}(m_{j,t+\tau} - m_{jt})/m_{jt}$$

Where q_{jt} is the directional quantity of $+1$ for a buyer-initiated trade and -1 for a seller-initiated trade, m_{jt} is the prevailing midpoint, and $m_{j,t+\tau}$ is the midpoint at time τ after the trade.

56. Reported realized spread is calculated as the average daily median trade-level realized spread in basis points, for days where Archegos is trading. The median is weighted by fill quantity. For a given trade and time horizon, the realized spread is a directional quantity multiplied against the trade price minus the horizon midpoint divided by the prevailing midpoint at time of trade. For buyer-initiated trades, this directional quantity is +1. For seller-initiated trades, this directional quantity is -1. That is, for a given trade at time *t* in stock *j* with time horizon τ, its realized spread is:

$$rs_{jt\tau} = q_{jt}(p_{jt} - m_{j,t+\tau})/m_{jt}$$

Where q_{jt} is the directional quantity of $+1$ for a buyer-initiated trade and -1 for a seller-initiated trade, p_{jt} is the trade price, m_{jt} is the prevailing midpoint, and $m_{j,t+\tau}$ is the midpoint at time τ after the trade.

iv. Results – Primary Approach

57. Professor Battalio will present the results of the price contribution analysis in table and graph format. Table 9, below, reports the price contribution of Archegos compared to other participants measured in dollar terms per 10,000 shares.

Table 6 - Price contribution per 10,000 shares over different time horizons (in seconds) using business hour active Archegos trades and trades from other market participants, April 1, 2020–March 23, 2021

Ticker	Segment	0.1	1	10	60	300
BIDU	Archegos	2.6	3.8	5.4	9.3	18.1
BIDU	Other	-0.2	-0.2	-0.1	1.1	2.2
DISCA	Archegos	0.3	0.4	0.5	0.9	1.8
DISCA	Other	0.0	0.0	0.1	0.2	0.2
DISCK	Archegos	0.3	0.5	0.7	0.9	1.4
DISCK	Other	0.0	0.1	0.1	0.1	0.2
FTCH	Archegos	0.6	1.0	1.3	1.7	3.2
FTCH	Other	0.0	0.0	0.1	0.1	0.7
FUTU	Archegos	-0.8	-1.2	-2.3	-4.6	-5.1
FUTU	Other	0.1	-0.1	-0.1	0.8	3.0
GSX	Archegos	1.0	1.5	2.5	3.1	0.4
GSX	Other	0.0	0.0	0.0	-0.5	-1.9
IQ	Archegos	0.2	0.3	0.4	0.7	1.4
IQ	Other	0.0	0.0	0.0	0.0	-0.1
RKT	Archegos	0.0	0.0	0.1	0.7	1.6
RKT	Other	0.0	0.0	0.0	0.2	-0.2
TCBI	Archegos	0.6	0.8	1.9	3.6	4.5
TCBI	Other	0.1	0.1	0.2	0.4	0.6
TME	Archegos	0.2	0.3	0.3	0.6	1.0
TME	Other	0.0	0.0	0.0	0.1	0.2
VIAC	Archegos	0.4	0.5	0.8	1.2	1.9
VIAC	Other	0.0	0.0	0.1	0.3	0.6
VIPS	Archegos	0.3	0.5	0.6	0.9	1.7
VIPS	Other	0.0	0.0	0.0	0.1	0.2

Based on the price contribution analysis, Professor Battalio will opine that, Archegos tended to have larger positive price contributions than other market participants in the Top Long Positions.

58. Professor Battalio will also present the results of the price impact analysis in table and graph format. Table 10, below, reports Average daily median price impact in basis points over different time horizons (in seconds) using business hour active Archegos trades and trades from other market participants, days where Archegos is trading between April 1, 2020 and March 23, 2021.

Table 7 - Average Daily Median Price Impact

Ticker	Segment	0.1	1	10	60	300
BIDU	Archegos	0.4	0.7	1.5	3.7	11.7
BIDU	Other	0.2	0.4	1.1	1.3	1.3
DISCA	Archegos	0.5	0.8	1.4	3.7	8.9
DISCA	Other	0.1	0.3	0.7	0.9	1.1
DISCK	Archegos	0.5	0.6	0.9	2.6	6.5
DISCK	Other	0.1	0.4	0.8	1.1	1.4
FTCH	Archegos	0.4	0.7	1.8	4.2	11.0
FTCH	Other	0.1	0.4	1.3	1.8	2.1
FUTU	Archegos	0.6	0.7	1.7	6.5	15.7
FUTU	Other	0.1	0.4	2.8	4.5	4.9
GSX	Archegos	0.4	1.1	2.8	6.9	11.9
GSX	Other	0.4	0.7	2.3	3.1	3.3
IQ	Archegos	1.0	1.8	2.9	6.4	14.8
IQ	Other	0.1	0.2	0.7	1.2	1.7
RKT	Archegos	0.7	1.3	2.5	6.4	13.9
RKT	Other	0.0	0.0	0.7	1.6	1.3
TCBI	Archegos	0.7	1.1	4.6	10.3	23.4
TCBI	Other	1.5	2.5	4.4	10.7	17.9
TME	Archegos	1.7	2.2	3.3	6.0	11.0
TME	Other	0.1	0.1	0.3	0.7	1.5
VIAC	Archegos	0.9	1.2	2.1	5.1	8.7
VIAC	Other	0.0	0.1	0.4	0.8	1.0
VIPS	Archegos	1.9	2.5	4.9	9.1	15.0
VIPS	Other	0.3	0.4	0.6	1.1	1.7

Based on the price impact analysis, Professor Battalio will opine that Archegos's orders altered prevailing prices in the associated securities.

59. Professor Battalio will present the results of the realized spread analysis in table and graph format. Table 11, below, reports Average daily median realized spread in basis points over different time horizons (in seconds) using business hour active Archegos trades and trades from other market participants, on days where Archegos is trading, between April 1, 2020 and March, 23 2021.

Table 8 - Realized Spreads Compared

Ticker	Segment	0.1	1	10	60	300
BIDU	Archegos	0.7	0.4	-0.1	-2.2	-10.0
BIDU	Other	0.7	0.6	0.4	0.4	0.4
DISCA	Archegos	0.1	-0.1	-0.4	-2.6	-7.8
DISCA	Other	0.5	0.4	0.2	0.5	0.4
DISCK	Archegos	0.4	0.3	0.3	-1.4	-5.2
DISCK	Other	0.6	0.4	0.2	0.1	0.0
FTCH	Archegos	1.2	1.1	0.4	-1.7	-8.2
FTCH	Other	1.0	0.9	0.8	0.6	0.8
FUTU	Archegos	3.6	3.5	3.0	-1.1	-10.0
FUTU	Other	3.2	3.0	1.7	0.8	0.7
GSX	Archegos	2.0	1.4	0.5	-2.9	-7.5
GSX	Other	1.8	1.6	0.9	0.8	0.8
IQ	Archegos	0.2	-0.4	-1.2	-4.8	-13.0
IQ	Other	1.1	0.8	0.6	0.5	0.4
RKT	Archegos	0.6	0.4	-0.6	-4.3	-11.5
RKT	Other	2.2	2.0	1.6	1.3	1.6
TCBI	Archegos	2.6	2.4	-0.7	-5.4	-18.4
TCBI	Other	3.8	3.6	4.1	5.2	1.5
TME	Archegos	-0.1	-0.5	-1.4	-3.6	-8.8
TME	Other	1.5	1.3	0.8	1.1	1.0
VIAC	Archegos	0.1	-0.1	-0.8	-3.6	-7.3
VIAC	Other	0.7	0.5	0.3	0.4	0.6
VIPS	Archegos	-0.3	-0.7	-3.1	-7.1	-13.0
VIPS	Other	1.0	0.9	0.5	0.5	0.4

60. Based on the realized spread analysis, Professor Battalio will opine that Archegos's trades delivered negative profitability for liquidity providers that traded against it. Moreover, Professor Battalio will explain that Archegos's realized spreads reverse the direction of normal realized spreads for sophisticated investment funds, as described in the academic literature.[29] The realized

[29] Frazzini, Andrea, Ronen Israel, and Tobias J. Moskowitz. "Trading costs." Available at SSRN 3229719 (2018). Beason, Tyler, and Sunil Wahal. "The anatomy of trading algorithms." Available at SSRN 3497001 (2020).

spread analysis reflects that Archegos's trading generate price drift beyond that caused by the trade itself and reflect price impact that exceeds what the market expected.

61. Professor Battalio will also present the results visually. Figure 13, Figure 14, and Figure 15 below illustrate that Archegos's market impact for BIDU, DISCA, and GSX significantly exceeded the price contribution and price impact of the other market participants. Figure 13 is in dollar terms per 10,000 shares. Figures 14 and 15 are in basis points.

Figure 13 - Price Contribution in BIDU: Archegos vs. Others

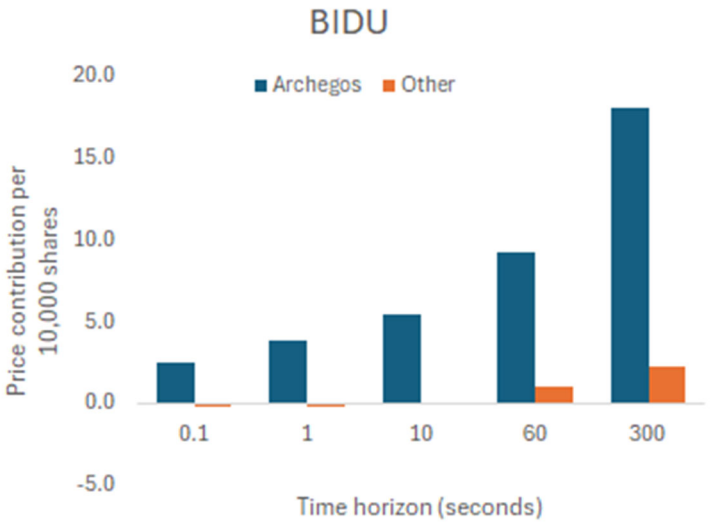


Figure 14 - DISCA Price Impact: Archegos vs. Others

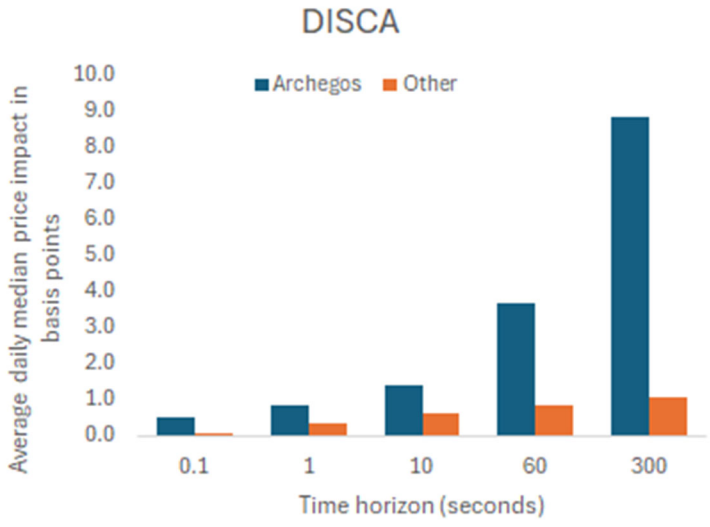
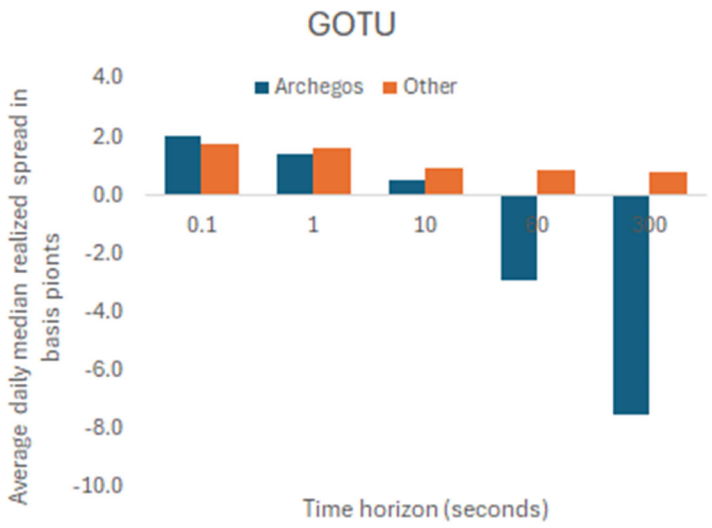


Figure 15 - GSX Realized Spread: Archegos vs. Others



62. Figure 16 and Figure 17 below illustrate that Archegos's market impact significantly exceeded the price impact of the other market participants in each of Archegos's Top Positions ten seconds after the trade. Figure 16 is in dollar terms per 10,000 shares. Figure 17 is in basis points.

Figure 16 - Archegos Price Contributions vs. Others After 10 Seconds

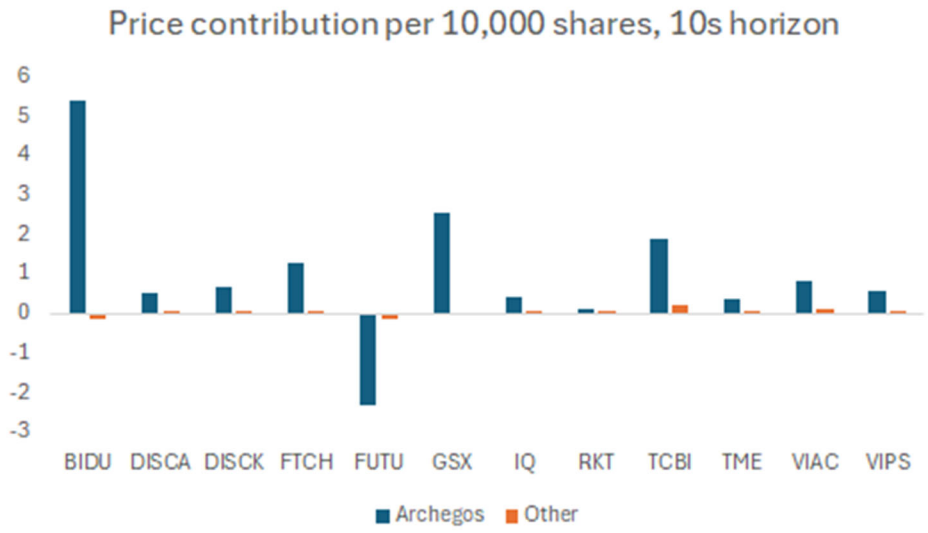
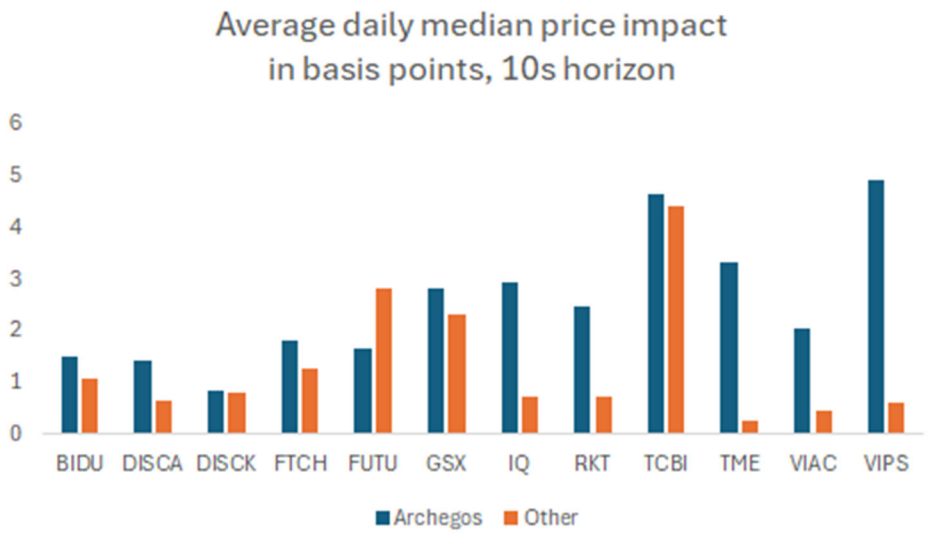
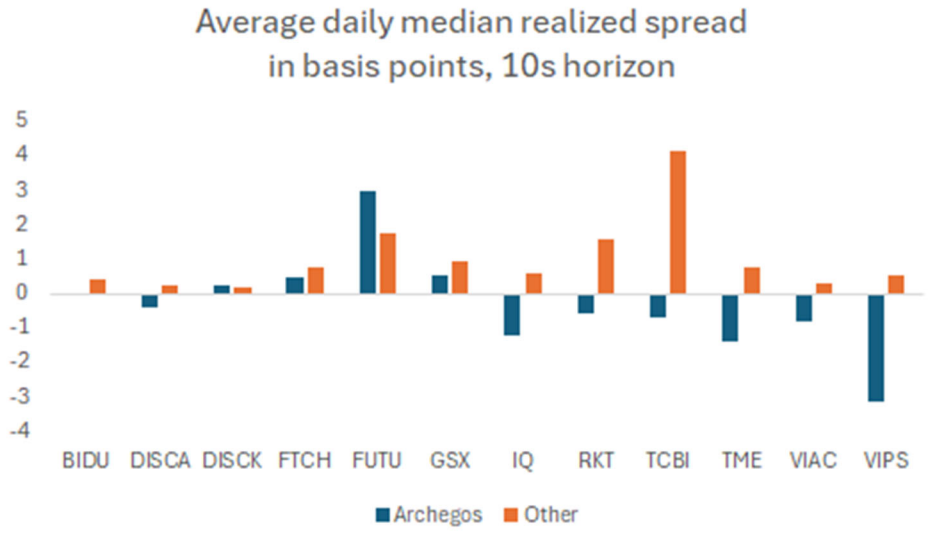


Figure 17 - Average Daily Median Price Impact After 10 Seconds



63. Figure 18 below illustrates the average daily median realized spread measured in basis points for Archegos and other market participants in each of Archegos's Top Positions ten seconds after the trade.

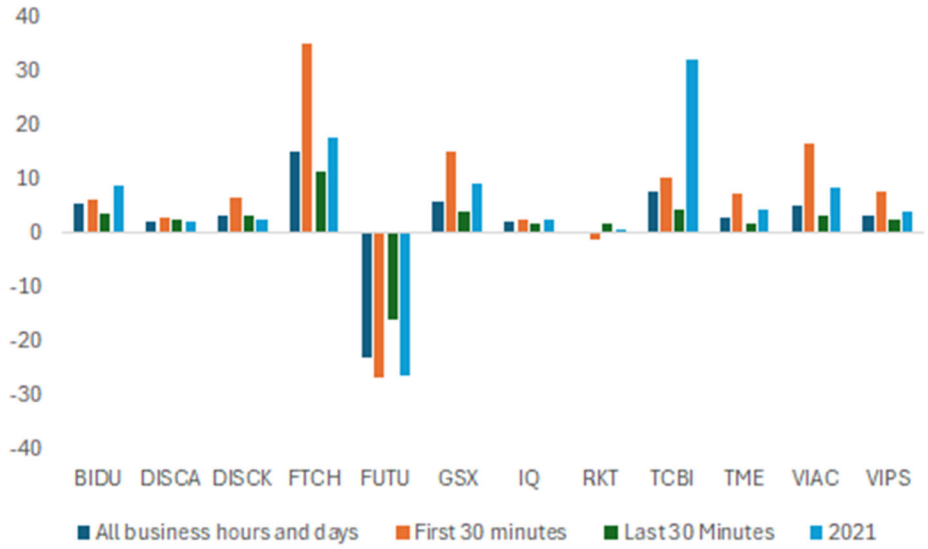
Figure 18 - Realized Spread: Archegos vs. Others



64. Professor Battalio will also present comparisons by time of day and time period. For example, the figures below compare differences in price contribution, price impact, and realized spread between Archegos and other market participants by first or last 30 minutes of the trading day from April 1, 2020 through March 23, 2021, as well as business hours from January 1, 2021 to March 23, 2021.[30]

65. Figure 19 reflects price contribution per 10,000 shares at a ten second horizon as a percentage of beginning price.

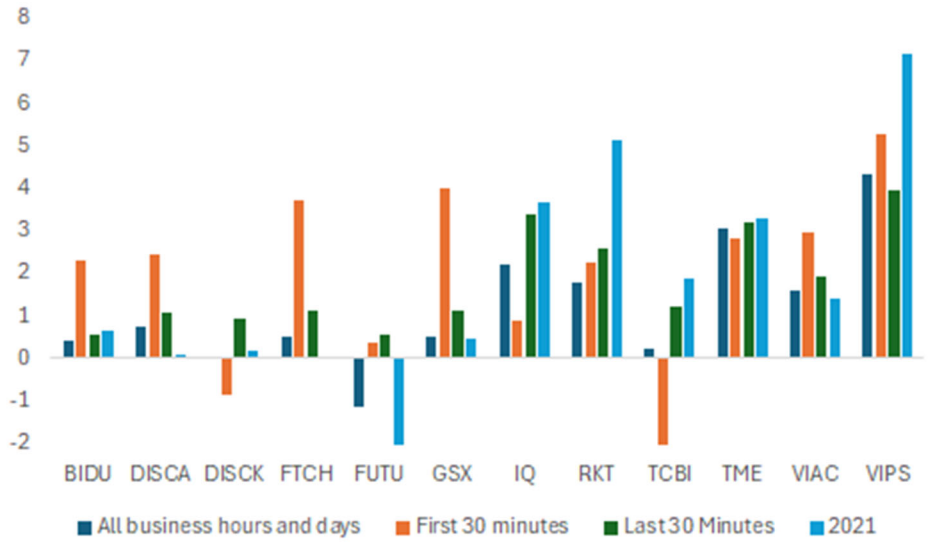
Figure 19 - Price Contribution at the Start of the Trading Day



[30] Beginning price as of August 6, 2020 close used for RKT; March 31, 2020 close used for other tickers.

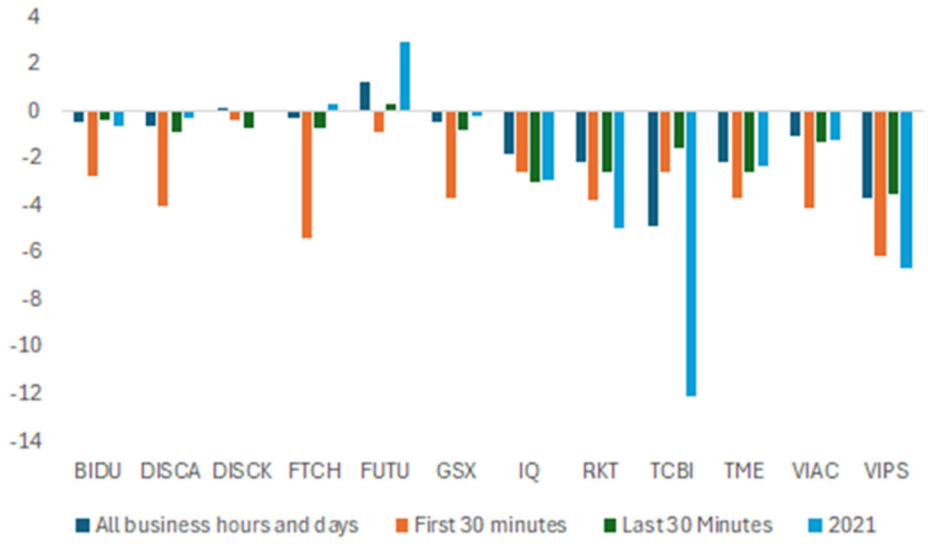
66. Figure 20 illustrates the difference between Archegos's price impact at various times of the trading day and other market participants, measured in basis points, for the period April 1 2020–March 23, 2021.

Figure 20 - Archego Price Impact by Time of Day



67. Figure 21 illustrates the difference between Archegos's realized spread at various times of the trading day and other market participants, at a ten second horizon, measured in basis points, for the period April 1, 2020 – March 23, 2021.

Figure 21 -Realized Spread Compared



68. Professor Battalio will opine that, taken together, the price impact, price contribution, and realized spread results individual and collectively confirm the VAR analysis results: Archegos's trading altered the prevailing market prices associated with the Top Archegos Positions. The results further demonstrate that Archegos's trading activity, as captured by these measures, was unusual by comparison to academic analysis of other investment funds and unexpected by reference to how market prices reacted to Archegos's trading.

v. Scope & Sources – Nasdaq Approach

69. Professor Battalio's Nasdaq midpoint analysis primarily relates to the October 1, 2020 through March 23, 2021 time period and includes a robustness check using the January 1, 2021 through March 23, 2021 time period. The analysis was conducted in R based on the Bloomberg EMSX data and the Nasdaq order book data.[31]

vi. Methodology – Nasdaq Approach

70. Professor Battalio's analysis will follow a methodology that is an adaptation of the Conrad and Wahal price impact measure.[32] Specifically, Professor Battalio will calculate the change in the midpoint from prior to a trade to after the trade is executed. If a trade is large enough to remove the entire volume at the best bid or best ask, then the trade will move the midpoint of the ticker, and the amount of change in the midpoint will be attributed as price impact (or price contribution) to the trade. The formula is as follows:

$$pi_{jn} = m_{j,n} - m_{jnp}$$

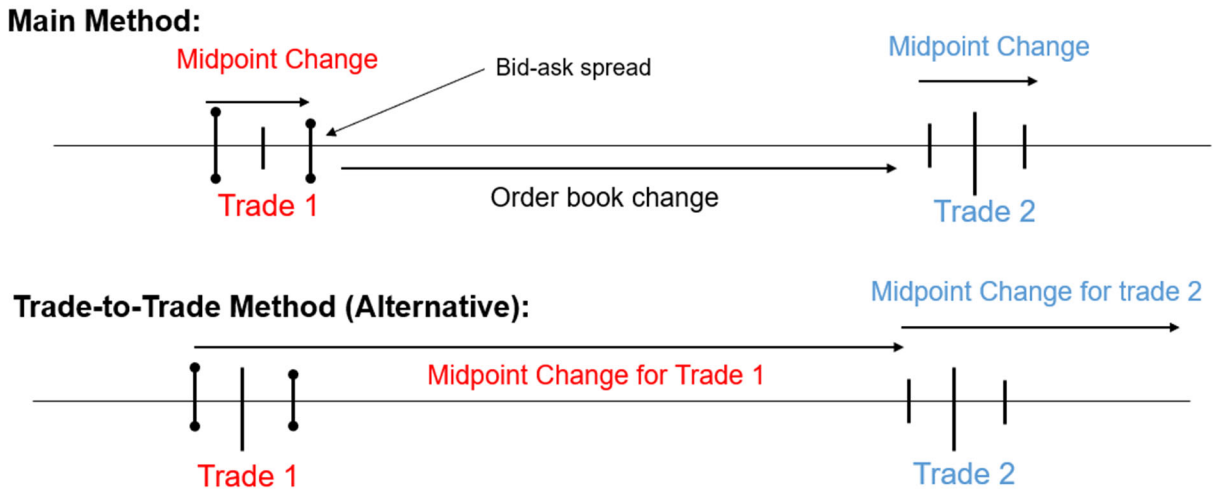
In the above formula, m_n refers to the midpoint after trade n, and m_{np} refers to the midpoint just prior to trade *n*. This is summed across all trades for Archegos and all trades for the rest of the market to develop Archegos's price impact. In Professor Battalios analysis, he does take into account reserve trades, which are orders on the order book but not visible to the market.

71. A stock's midpoint can further change between the execution of one trade (trade *n*) and

[31] Archegos trades have been identified in the Nasdaq data following the matching process described above and reflected in the file "nasdaq_with_match_v1.fst." The Nasdaq order book was reconstructed using order, execution, and cancellation data. The code used to build the order book is being produced to the defense.

[32] *See, for example*, Conrad, Jennifer, and Sunil Wahal. "The term structure of liquidity provision." *Journal of Financial Economics* 136, no. 1 (2020): 239-259. *See also* Chakravarty, Sugato. "Stealth-trading: Which traders' trades move stock prices?." *Journal of Financial Economics* 61, no. 2 (2001): 289-307.

just prior to the execution of the next trade, often due to liquidity makers adding liquidity to the order book. The methodology described above does not include these changes in the order book in the price impact calculation of a given trade. As a robustness check, Professor Battalio also performed the analysis using a change in midpoint from just prior to trade *n* to just prior to the next trade. This attributes changes in the order book midpoint on Nasdaq to the executed trade immediately preceding the order book change. A visual description of the different methodologies is demonstrated below.



vii. Results

72. Table 9 presents the price impact results for the period from October 1, 2020 through March 23, 2021:

Table 9

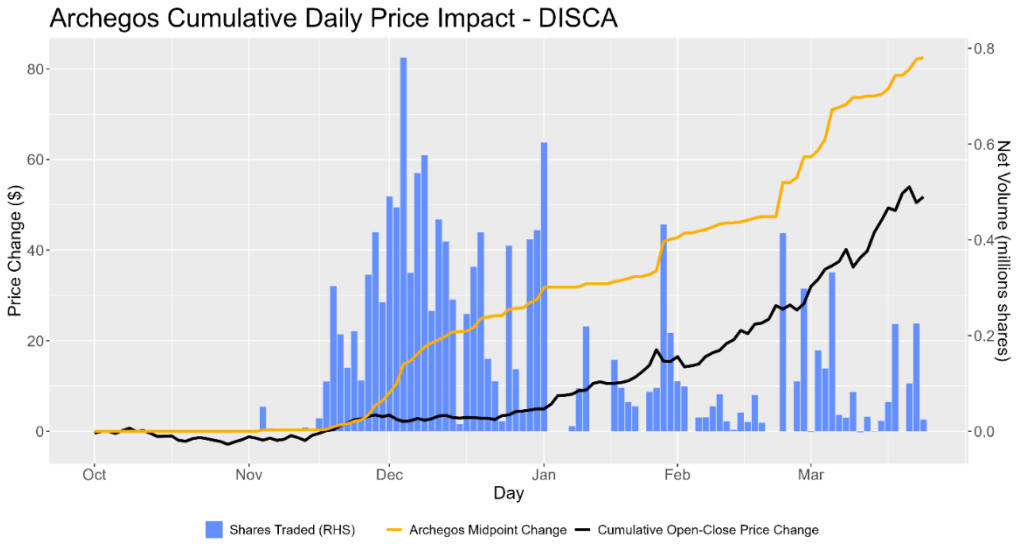
Ticker	Method	Archegos Price Impact	Non-ARC Price Impact	Order Book Change
DISCA	Main	82.47	-105.02	74.64
DISCA	Alternative	155.40	-103.65	N/A
DISCK	Main	212.89	-52.87	-111.13
DISCK	Alternative	383.54	-334.11	N/A
VIAC	Main	258.27	-50.18	-133.42
VIAC	Alternative	511.88	-430.59	N/A
IQ	Main	65.94	-46.01	2.45
IQ	Alternative	126.83	-104.06	N/A

As reflected by the results, the analysis demonstrates that Archegos's trading in DISCA, DISCK, IQ, and VIAC resulted in price impact, that Archegos's price impact moved against the market, and resulted in changes to the prevailing midpoint.

73. Professor Battalio will present the price impact analysis in graphs that compare the actual price change and Archegos's trade volume. [33]

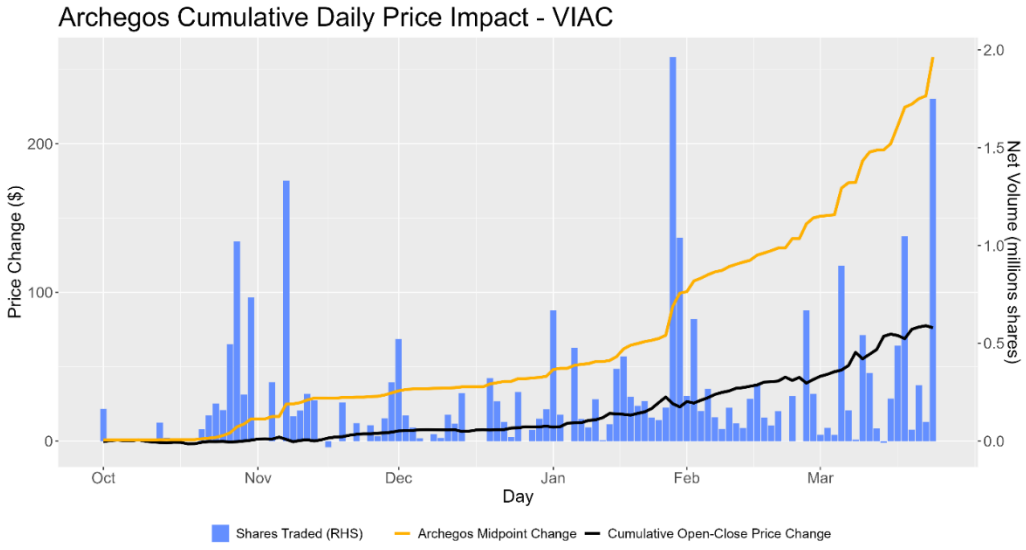
74. For example, Figure 22, below, illustrates the relationship between Archegos's trading and changes in the prevailing midpoint of DISCA.

Figure 22 - Archegos Cumulative Price Impact in DISCA



75. Figure 23, below, illustrates the relationship between Archegos's trading and changes in the prevailing midpoint of DISCA.

Figure 23 - Archegos Cumulative Price Impact in VIAC



[33] Additional results have been generated and produced.

3. Probit Analysis

i. Overview

76. As described in the Initial Battalio Notice, Professor Battalio will present the results of a type of statistical analysis known as a probit model, which aims to mathematically represent the link between contemporaneous market conditions and changes to Archegos's order sizes and limit prices. As discussed further below, Professor Battalio's probit model shows that Archegos would tend to increase its order sizes and limit prices when (a) stock prices fell below the previous day's market close, (b) shortly after market open, and (c) shortly before market close.

ii. Scope & Sources

77. Professor Battalio's probit analysis evaluated Archegos's trading in DISCA, DISCK, FTCH, GSX, IQ, TME, VIAC, VIPS, BIDU, and TCBI based on activity from 4/1/2020 through 3/23/2021. For the main regression results, the start date used was the later of 4/1/2020 or the date at which Archegos's exposure to an issuer equated to 5% of shares outstanding. The model was run using Stata code.[34]

78. Professor Battalio's probit analysis uses three primary data inputs: Archegos's EMSX data maintained by Bloomberg was used to determine if an order was changed. Market-wide trade-and-quote data was used to determine market-wide imbalance and volume.[35] TAQ NBBO data is used to determine the minute-level prices and returns.[36]

iii. Methodology

79. Professor Battalio's primary probit model is summarized by this equation:

$$\begin{aligned}\Pr(change_{i,t}) = {} & \beta_1 \Delta P_{i,t,t-15} + \beta_2 AvgImb_t + \beta_{3-5} VolQ_t + \beta_{6-8} AvgImb_t * VolQ_t \\ & + \beta_9 \Delta prevClose_i + \beta_{10} recentChange_{t-1,t-15} + \beta_{11} PctFill + \beta_{12} last30 \\ & + \beta_{13} first30 + \beta_{14} last10 + \beta_{15} RecFill\end{aligned}$$

The key variables to the probit model are defined as follows:

- *Change* is an indicator variable for whether Archegos changed its order for stock *i* in minute *t*. This could be an increase in the order quantity, increase in limit price, or decrease in limit price.
- *ΔP* is the stock's return over the preceding 15 minutes.
- *Avg Imbalance* is the market-wide imbalance over the minute, defined as [(buys – sells)/(buys + sells)]

[34] The code used to complete the analysis is in file "3_order_regs2_volume_interaction.do."
[35] Includes intermediate sql table doj_arc.volume_by_minute_typed.
[36] Includes intermediate sql table doj_arc.closing_midpoint_price_by_minute.

- *VolQ* is an indicator for if the volume in that minute was in the top quartile, second quartile, or third quartile of the previous day's distribution of volume by minute.
- *PrevClose* is the percent difference from the stock's prior day close (that is, the return since prior day close).
- *RecChange* is an indicator if Archegos changed its order in the last 15 minutes.
- *PctFilled* is the percentage of current outstanding orders that have been filled by minute *t*.
- *Last30*, *first30,* and *last10* are indicators for whether *t* is in the last 30 minutes, first 30 minutes, or last 10 minutes of the day (respectively).
- *RecentFill* indicator is also included in some regressions for if an Archegos order was filled within the last 5 minutes.

80. Professor Battalio confirmed the robustness of the primary probit model through additional robustness regressions. Other variables in robustness regressions are defined as follows:

- *Pc_ind* is included in some regressions as an indicator for whether the price in a given minute is below the previous day's close.

Regression dependent variables for *change* are defined as follows:

- increase in the quantity of an order (new orders count as quantity increase)
- an increase in the limit price
- a decrease in the limit price

Regressions were estimated with Newey-West standard errors to account for possible auto-correlation in the data.

iv. Results

81. The primary probit model produces the following results:[37]

Table 10 - Primary Probit Results (DISCA, DISCK, FTCH, GSX, IQ)

Ticker	**DISCA**	**DISCK**	**FTCH**	**GSX**	**IQ**
Return - 15 min	-9.021***	-5.960	-14.268***	-8.584***	-17.865***
	(-3.201)	(-1.173)	(-6.709)	(-5.482)	(-6.084)
Avg Imbalance	-0.494***	-0.019	-0.126	-0.041	0.069
	(-3.912)	(-0.119)	(-1.025)	(-0.561)	(0.656)
Volume 1st quartile	0.357***	0.421***	0.360***	0.425***	0.455***
	(6.707)	(5.980)	(7.115)	(11.922)	(9.206)
Volume 2nd quartile	0.130**	0.102	0.180***	0.244***	0.194***
	(2.279)	(1.318)	(3.279)	(6.296)	(3.680)
Volume 3rd quartile	0.033	0.163**	0.079	0.117***	0.092
	(0.558)	(2.240)	(1.382)	(2.872)	(1.612)

[37] The Government is also producing output tables, which include further results, in the folder "Tables_since_5%". Additional robustness checks and specifications are produced in the folders "Tables_Jan_through_Mar23_2021" and "Tables_Oct_through_Dec_2020."

Avg Imbalance & Volume 1st quartile interaction	0.033	-0.050	0.097*	-0.004	-0.015
	(0.716)	(-0.734)	(1.890)	(-0.125)	(-0.340)
Avg Imbalance & Volume 2nd quartile interaction	0.078	-0.028	-0.006	0.001	-0.021
	(1.430)	(-0.349)	(-0.111)	(0.037)	(-0.424)
Avg Imbalance & Volume 3rd quartile interaction	0.049	-0.023	0.023	0.023	-0.031
	(0.808)	(-0.290)	(0.363)	(0.603)	(-0.607)
Price Relative to Prev. Close (%)	-3.303***	-1.784**	-4.071***	-1.574***	-3.337***
	(-5.193)	(-2.412)	(-7.948)	(-7.849)	(-9.083)
Recent Change Indicator	-0.021	-0.110**	0.381***	0.517***	0.511***
	(-0.437)	(-2.081)	(7.895)	(15.899)	(12.442)
Pct. of Current Filled	0.416***	0.415***	0.226**	0.005***	0.445***
	(7.582)	(5.829)	(2.471)	(2.877)	(10.487)
Last 30 min of Trading Day	0.149**	0.026	0.193***	0.171***	0.283***
	(1.981)	(0.269)	(3.385)	(3.818)	(5.820)
First 30 min of Trading Day	0.329***	0.552***	0.126*	0.174***	0.117
	(4.272)	(5.977)	(1.707)	(3.352)	(1.622)
Last 10 min of Trading Day	-0.246*	-0.191	-0.236**	0.058	-0.145*
	(-1.868)	(-1.318)	(-2.225)	(0.804)	(-1.807)
Recent Fill	1.001***	0.831***	0.859***	0.861***	0.889***
	(15.467)	(12.163)	(14.065)	(22.724)	(16.585)
N	31834	11220	50908	83820	89804
Ticker	DISCA	DISCK	FTCH	GSX	IQ

Table 11 - Primary Probit Results (TME, VIAC, VIPS, BIDU, TCBI)

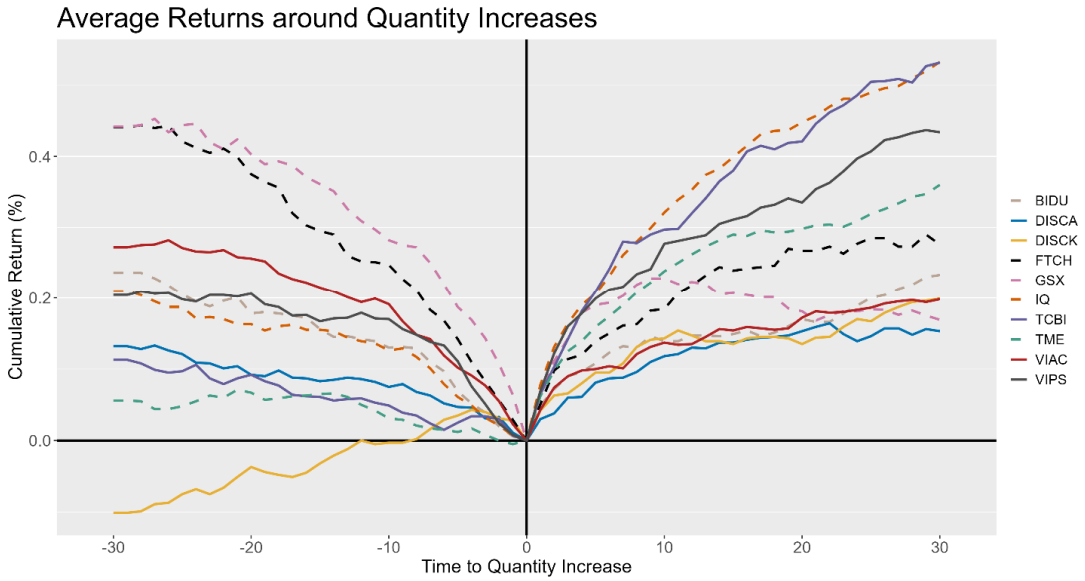
Ticker	**TME**	**VIAC**	**VIPS**	**BIDU**	**TCBI**
Return - 15 min	-14.373***	-12.542***	-22.681***	-12.795***	-2.925
	(-5.077)	(-4.432)	(-6.655)	(-4.224)	(-0.969)
Avg Imbalance	-0.153**	-0.285**	0.293**	-0.218	0.061
	(-2.422)	(-2.521)	(2.438)	(-1.318)	(0.564)
Volume 1st quartile	0.547***	0.491***	0.393***	0.409***	0.317***
	(13.496)	(12.302)	(6.418)	(7.277)	(5.105)
Volume 2nd quartile	0.185***	0.221***	0.177***	0.245***	0.014
	(4.160)	(5.128)	(2.676)	(4.449)	(0.191)
Volume 3rd quartile	0.060	0.124***	-0.009	0.124**	-0.013
	(1.244)	(2.780)	(-0.127)	(2.038)	(-0.196)
Avg Imbalance * Volume 1st quartile interaction	0.033	0.001	0.008	-0.021	-0.053
	(0.920)	(0.028)	(0.141)	(-0.396)	(-0.849)
Avg Imbalance & Volume 2nd quartile interaction	0.021	0.036	-0.051	0.015	-0.022
	(0.533)	(0.886)	(-0.838)	(0.265)	(-0.281)
Avg Imbalance & Volume 3rd quartile interaction	0.018	-0.005	-0.167***	0.045	0.036
	(0.400)	(-0.101)	(-2.592)	(0.733)	(0.530)
Price Relative to Prev. Close (%)	-4.611***	-4.375***	-5.862***	-4.526***	-5.134***
	(-8.899)	(-8.570)	(-7.679)	(-8.079)	(-8.484)
Recent Change Indicator	0.564***	0.204***	0.297***	0.339***	0.506***
	(15.275)	(5.823)	(5.559)	(6.698)	(8.041)

Pct. of Current Filled	0.009	0.352***	0.643***	0.383***	1.345***
	(1.228)	(4.378)	(10.304)	(5.102)	(16.245)
Last 30 min of Trading Day	0.189***	0.278***	0.329***	0.292***	0.145**
	(4.091)	(6.496)	(4.972)	(4.913)	(2.097)
First 30 min of Trading Day	0.068	0.128**	0.248***	-0.222**	0.085
	(1.105)	(2.176)	(3.138)	(-2.065)	(0.751)
Last 10 min of Trading Day	-0.061	0.012	-0.061	-0.000	-0.077
	(-0.879)	(0.171)	(-0.636)	(-0.003)	(-0.760)
Recent Fill	0.863***	0.893***	0.848***	0.825***	1.196***
	(18.704)	(22.343)	(11.406)	(12.530)	(11.799)
N	91674	78210	47916	49786	91674

82. Professor Battalio will opine that the probit analysis demonstrates that Archegos was more likely to increase order sizes when (i) stock prices were declining, (ii) when stock prices fell below the previous day's market close, (iii) shortly after market open, and (iv) shortly before market close. Professor Battalio will opine that such stock purchase decisions were consistent with a strategy to increase stock prices.

83. Professor Battalio will also present analysis of Archegos's order changes. Figure 24, below, illustrates the relationship between price returns and Archegos's order sizes. Specifically, Figure 21 illustrates that Archegos would tend to increase order sizes in response to a decline in price returns. Further, this analysis demonstrates that when Archegos increased order sizes, price increases often followed and that those price increases would have been observable to market participants—including Archegos itself—in market data feeds.

Figure 24 - Archegos Order Quantity Increases When Prices Slip



F. Uneconomic Trading

84. As described in the Initial Battalio Notice, Archegos's trading during the March 2020 through March 2021 period included numerous uneconomic trading behaviors.

1. Same Day Buying and Selling

85. Based on the EMSX records, Professor Battalio will identify multiple instances in which Archegos bought and short-sold the same stock, including on the same day. This analysis was done in a Python Jupyter notebook and relies on Archegos order and execution records maintained by Bloomberg.

86. Based on this analysis, Professor Battalio will present the information reflected in Table 12, below, which sets forth the days during which Archegos engaged in buying and selling on the same day.

Table 12 - Same Day Buying & Selling

Date	BIDU	DISCA	GSX	VIAC
3/1/2021		SELL SHORT	BUY, SELL SHORT	BUY
3/2/2021	BUY	BUY	BUY	BUY
3/3/2021	BUY	BUY	BUY, SELL SHORT	BUY
3/4/2021	BUY	BUY	BUY, SELL SHORT	BUY
3/5/2021	BUY	BUY	BUY, SELL SHORT	BUY
3/6/2021				
3/7/2021				
3/8/2021	BUY, SELL	BUY	BUY	BUY
3/9/2021	BUY	BUY	BUY	BUY
3/10/2021	BUY	SELL SHORT	BUY	BUY, SELL SHORT
3/11/2021		BUY, SELL SHORT	SELL SHORT	BUY, SELL SHORT
3/12/2021	BUY	SELL SHORT	BUY	BUY, SELL SHORT
3/13/2021				
3/14/2021				
3/15/2021	BUY	BUY, SELL SHORT	BUY, SELL SHORT	BUY, SELL SHORT
3/16/2021	BUY	BUY, SELL SHORT	BUY, SELL SHORT	BUY
3/17/2021	BUY, SELL	BUY	BUY	BUY
3/18/2021	BUY	BUY	BUY	BUY, SELL SHORT
3/19/2021	BUY	BUY	BUY	BUY, SELL SHORT

3/20/2021				
3/21/2021				
3/22/2021	BUY	BUY	BUY	BUY, SELL SHORT
3/23/2021	BUY, SELL	BUY	BUY, SELL, SELL SHORT	BUY
3/24/2021	BUY, SELL SHORT			

2. Internally Inconsistent Market Activity

87. As set forth in the Initial Battalio Notice, Professor Battalio has identified instances in which Archegos sought long exposure to VIAC, GSX, DISCA, and FUTU at a higher price than they recently sought short exposure. Professor Battalio identified these occasions by comparing the price of an executed short sell trade to the average price of the next set of buys of that same quantity, resembling a first-in, first-out calculation, using Archegos order and execution records maintained by Bloomberg. Professor Battalio conducted the analysis in a Python Jupyter notebook and then transferred specific trade records to Excel. The analysis considered all the short-sell trades during the time frame of March 1, 2021 – March 23, 2021 for VIAC, GSX, and DISCA and during the time frame of January 1, 2021 – January 31, 2021 for FUTU.

88. Professor Battalio will present a table of all the instances there was a short sell trade and highlight the specific occurrences that there were buys for a higher price following the short exposure. Table 13 is an illustrative portion of the dataframe that illustrates VIAC short exposure followed by VIAC long exposure.[38] The highlighted rows are the uneconomic shorts, where the average price of the bought shares is higher than the price of the shorted shares.

Table 13 - Example VIAC Inconsistent Buys & Sells

short_price	short_time	short_q	avg_price_buy	time_last_buy	buy_q
94.6463	3/12/21 15:27	2400	94.854938	3/15/21 13:29	6159
94.6495	3/12/21 15:27	3300	94.854938	3/15/21 13:29	3759
94.6513	3/12/21 15:27	1500	94.83430858	3/15/21 13:29	1607
95.13	3/12/21 15:29	3900	94.868971	3/15/21 13:29	6784
95.1198	3/12/21 15:29	2700	94.877496	3/15/21 13:29	2884
95.1079	3/12/21 15:29	2800	94.87958875	3/15/21 13:29	11384
94.6561	3/12/21 15:29	1000	94.902414	3/15/21 13:29	8584
94.6659	3/12/21 15:29	2100	94.902414	3/15/21 13:29	7584
95.1115	3/12/21 15:29	1000	94.902414	3/15/21 13:29	5484
94.6717	3/12/21 15:29	1000	94.902414	3/15/21 13:29	4484
94.6775	3/12/21 15:29	1000	94.902414	3/15/21 13:29	3484
94.6815	3/12/21 15:29	1000	94.902414	3/15/21 13:29	2484
95.1024	3/12/21 15:29	1800	94.90288375	3/15/21 13:29	2084
94.6741	3/12/21 15:32	1000	94.9046182	3/15/21 13:29	1284
94.6669	3/12/21 15:32	1000	94.906428	3/15/21 13:29	1284
94.6598	3/12/21 15:32	1000	94.908403	3/15/21 13:29	1010
94.6532	3/12/21 15:32	1000	94.86751751	3/15/21 13:30	1047
94.6465	3/12/21 15:32	1000	94.79413124	3/15/21 13:30	1147

89. Professor Battalio will also present summary statistics that demonstrate the prevalence of

[38] The full table will be produced for the VIAC, GSX, DISCA, and FUTU tickers.

Archegos's uneconomic shorting in VIAC, DISCA, DISCK, and GSX.

90. Table 14 reports summary statistics for VIAC from March 1, 2021 – March 23, 2021:

Table 14 - Uneconomic Trading in VIAC

Number of Trades	308693
Number of Shorts	7689
Number of Un-Economic Shorts	4877
Shares of Un-Economic Shorts	1308093
Shares of Un-Economic Shorts %	0.536875557
Average Price Delta of Shorts	-0.730964612
Average Price Delta of Un-Economic Shorts	-2.40146639
Average Time to Cover of Shorts (Hours)	13.86599797
Average Time to Cover of Un-Economic Shorts (Hours)	19.52406321

91. Table 15 reports summary statistics for GSX from March 1, 2021 – March 23, 2021:

Table 15 - Uneconomic Trading in GSX

Number of Trades	116495
Number of Shorts	6053
Number of Un-Economic Shorts	3218
Shares of Un-Economic Shorts	763025
Shares of Un-Economic Shorts %	0.4978
Average Price Delta of Shorts	0.0543
Average Price Delta of Un-Economic Shorts	-2.1195
Average Time to Cover of Shorts (Hours)	15.1486
Average Time to Cover of Un-Economic Shorts (Hours)	18.3810

92. Table 16 reports summary statistics for DISCA from March 1, 2021 – March 23, 2021:

Table 16 - Uneconomic Trading in DISCA

DISCA Shorts Summary: March 1, 2021 – March 23, 2021	
Number of Trades	132913
Number of Shorts	6994
Number of Un-Economic Shorts	5533
Shares of Un-Economic Shorts	1592659
Shares of Un-Economic Shorts %	0.6049
Average Price Delta of Shorts	-1.4158
Average Price Delta of Un-Economic Shorts	-2.0326
Average Time to Cover of Shorts (Hours)	27.5618
Average Time to Cover of Un-Economic Shorts (Hours)	30.9777

93. Table 17 reports summary statistics for FUTU from March 1, 2021 – March 23, 2021:

Table 17 - Uneconomic Trading in FUTU

Number of Trades	92741
Number of Shorts	42652
Number of Un-Economic Shorts	35261
Shares of Un-Economic Shorts	4175014
Shares of Un-Economic Shorts %	0.8175
Average Price Delta of Shorts	-7.4529
Average Price Delta of Un-Economic Shorts	-9.9627
Average Time to Cover of Shorts (Hours)	42.2597
Average Time to Cover of Un-Economic Shorts (Hours)	48.5107

94. Table 18 reports summary statistics for BIDU from March 22, 2021 – March 24, 2021:

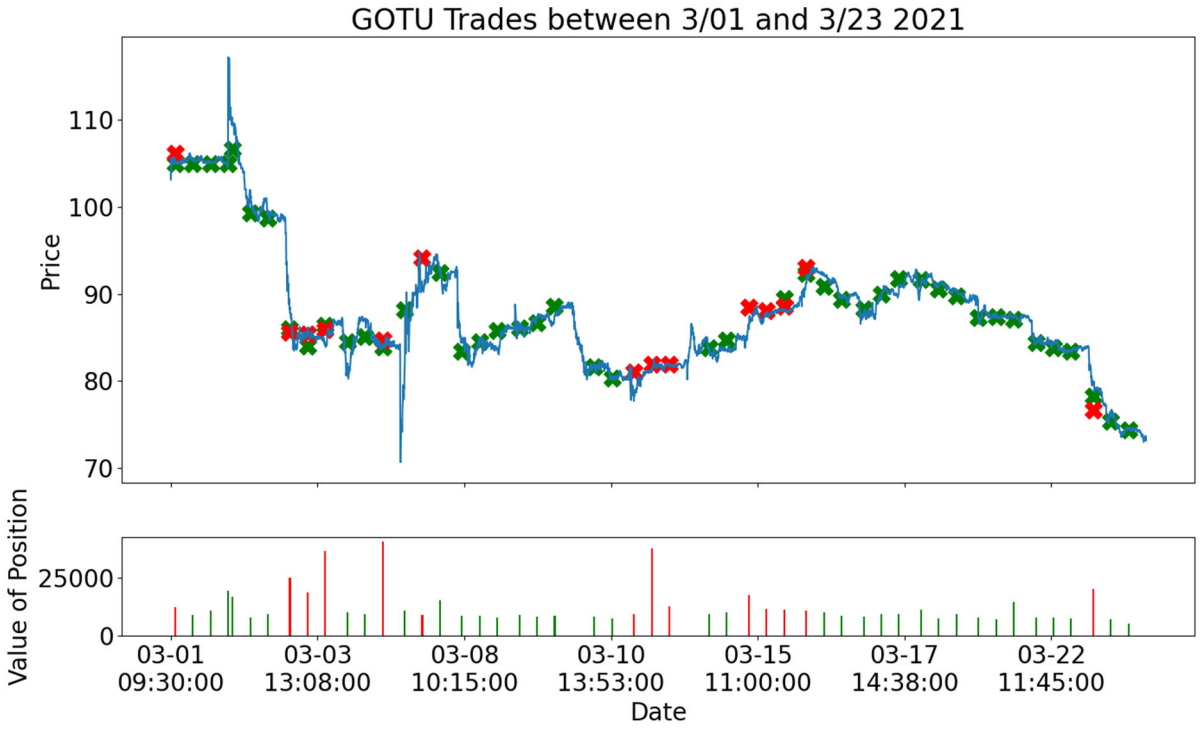
Table 18 - Uneconomic Trading in BIDU

Number of Trades	77735
Number of Shorts	146
Number of Un-Economic Shorts	0
Shares of Un-Economic Shorts	0
Shares of Un-Economic Shorts %	0
Average Price Delta of Shorts	7.5011
Average Price Delta of Un-Economic Shorts	
Average Time to Cover of Shorts (Hours)	1.8106

Average Time to Cover of Un-Economic Shorts (Hours)	

95. Professor Battalio will also present the data regarding uneconomic shorting activity in the form of price plot graphs. These graphs track the price of the ticker, the weighted average price of grouped buys and short sell trades, as well as the values of these trades. For VIAC, DISCA, and GSX, the graphs will cover March 1, 2021 – March 23, 2021. For FUTU, the graphs will cover the period of January 1, 2021 – January 31, 2021. These graphs were produced using a Python Jupyter notebook. Figure 20, below, is an example of GSX trading with short sales marked in red and buys marked in green.

Figure 25 - GSX Uneconomic Trades March 1, 2021 - March 23, 2021



96. Based on his analysis of occasions when Archegos bought and sold the same names on the same day and sought more expensive long exposure soon after they recently sought short exposure, Professor Battalio will opine that Archegos's order submission strategies were consistent with a strategy to influence market prices in the Archegos Top Securities and inconsistent with a strategy to build concentrated positions in the Top Archegos Securities at the best available prices.

3. Archegos Algorithm Choices

97. Based on Archegos's EMSX order and execution information maintained by Bloomberg, Professor Battalio will observe that Archegos frequently instructed its counterparties to execute its orders using specific algorithms.

98. For the period January 4, 2020 through March 23, 2021, Professor Battalio grouped together order strategies into the following categories:[39]

- Dark
- POV (including trading-in-line and participate)
- Pure Dark
- SWAP
- TWAP
- VWAP
- DMA
- VWAP/TWAP

For each security, Professor Battalio summarized the proportion of the Archegos buy orders and the proportion of the Archegos sell orders placed under each strategy category. This analysis was primarily done in R and Microsoft Excel. For this analysis, consistent with other analyses, orders refer to parent orders and also includes instances when order instructions changed. (These parent orders are in the intermediate table, par_orders.fst, derived from the Archegos EMSX data obtained from Bloomberg.)

99. Professor Battalio will present summary statistics regarding Archegos's use of Algorithms. Table 20, below, reflects Archegos's use of algorithms based on the quantity of shares filled. The table presents the percentage of buys or sells for each ticker based on the mapped strategies.

Table 19 - Archegos Algorithm Selection

Ticker	bs	DMA	Dark	Other	POV	Pure Dark	SWAP	TWAP	VWAP	VWAP /TWAP
BIDU	Buy	0.3	9.0	12.7	46.9	1.4	1.9	7.5	20.2	0.0
BIDU	Sell	2.2	22.7	37.1	0.0	36.3	0.0	1.4	0.3	0.0
DISCA	Buy	0.1	11.3	11.6	37.4	3.1	16.2	4.5	15.6	0.2
DISCA	Sell	0.1	8.8	14.2	2.0	74.9	0.0	0.0	0.0	0.0
DISCK	Buy	0.0	8.0	8.9	59.5	1.8	0.0	9.2	12.6	0.0
FTCH	Buy	0.0	18.0	4.4	52.8	1.8	2.7	8.5	11.8	0.0
FTCH	Sell	0.0	57.2	0.0	0.0	42.8	0.0	0.0	0.0	0.0
FUTU	Buy	0.0	14.2	1.1	1.6	83.1	0.0	0.0	0.0	0.0
FUTU	Sell	6.0	15.6	5.1	36.8	4.6	0.0	12.7	15.0	4.3
GOTU	Buy	0.4	17.1	23.5	32.2	6.2	15.5	2.1	2.9	0.0
GOTU	Sell	5.9	4.3	22.1	4.3	63.3	0.0	0.0	0.0	0.0
IQ	Buy	0.0	22.9	21.2	28.2	7.6	9.4	3.4	7.4	0.0
IQ	Sell	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
RKT	Buy	0.0	20.3	8.6	31.7	35.8	3.6	0.0	0.0	0.0
RKT	Sell	0.4	22.0	5.9	32.5	15.0	0.0	12.5	11.7	0.0

[39] Category mapping identified in the file strat_map.csv, to be provided.

TCBI	Buy	0.0	41.3	36.0	0.0	11.2	6.4	2.2	3.0	0.0
TME	Buy	1.5	20.3	11.6	45.3	4.9	3.1	3.0	10.3	0.0
TME	Sell	0.0	23.9	0.0	0.0	76.1	0.0	0.0	0.0	0.0
VIAC	Buy	1.0	16.8	17.2	40.8	3.6	5.8	5.2	9.5	0.0
VIAC	Sell	1.0	2.8	5.0	7.6	80.2	0.0	0.0	3.5	0.0
VIACA	Buy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.3	32.7
VIPS	Buy	0.0	22.7	5.2	51.6	6.0	0.0	4.3	10.1	0.0
VIPS	Sell	0.0	86.8	10.9	0.0	2.4	0.0	0.0	0.0	0.0

100. Based on the same analysis, Professor Battalio will present summary statistics for the last 30 minutes, last 10 minutes, and the rest of the day (between the market open and last 30 minutes). The tables are also generated for the number of trades (as opposed to quantity filled).

101. Professor Battalio will present the results in visual format in addition to table format. For example, Figure 26, Figure 27, and Figure 28 illustrate that Archegos used participation-based and time-based algorithms when executed trades in the same direction as the firm's overall position but used dark pool algorithms when executing trades in the opposite direction to the firm's overall position. Professor Battalio will opine that academic research demonstrates that dark pools tend to have less price impact that lit markets. Accordingly, Archegos's choice of algorithms reflects that Archegos tended to select impact-mitigating trade venues when trading in the opposite direction of its interest and traded in other venues when trading in the direction of its interest.

Figure 26 - Archegos DISCA Trading by Algorithm

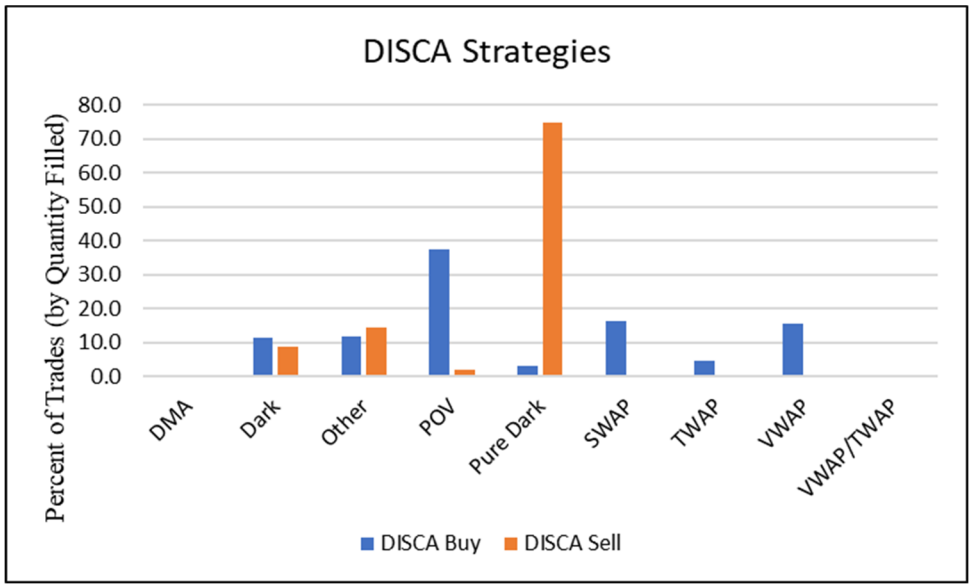


Figure 27 - Archegos FUTU Trading by Algorithm

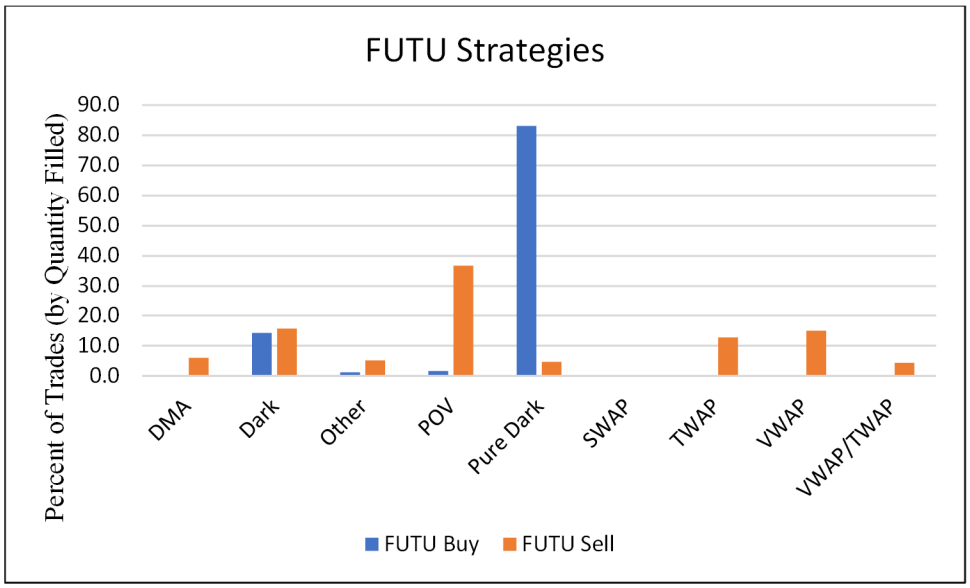
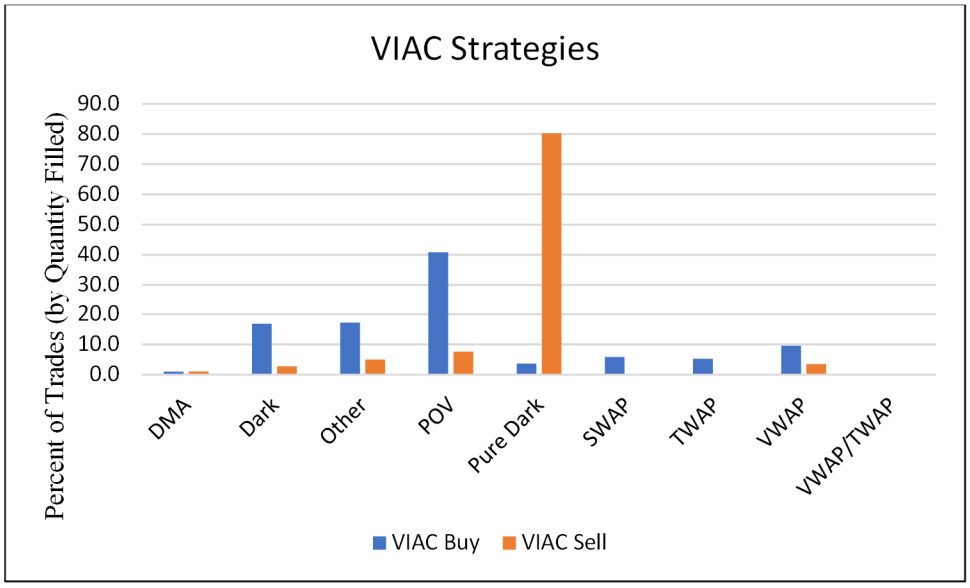


Figure 28 - Archegos VIAC Strategies by Algorithm



102. Professor Battalio similarly calculated Archegos's use of strategies during three daily periods:

- Last 10 minutes
- Last 30 minutes (includes last 10 minutes)
- Rest of day (not last 10 or last 30 minutes)

103. Professor Battalio will present the results in table form. For example, Table 21, below, reports Archegos's algorithm choices during the last 30 minutes of a trading day (as a percentage of shares filled). (N/A indicates there were no transactions of that type in the last 30

minutes).

Table 20 - Archegos Algorithm Choice During Last 30 Minutes

Ticker	Side	Dark	Other	POV	Pure Dark	SWAP	TWAP	VWAP	DMA	VWAP/ TWAP
BIDU	Buy	1.3	10.6	20.1	0.8	1.7	13.7	51.7	0.0	0.0
BIDU	Sell	12.9	7.0	0.0	27.8	0.0	0.0	5.9	46.3	0.0
DISCA	Buy	2.8	4.5	7.5	4.7	28.0	13.8	36.9	0.8	1.0
DISCA	Sell	15.6	63.1	0.0	21.3	0.0	0.0	0.0	0.0	0.0
DISCK	Buy	3.5	1.6	8.3	0.0	0.0	35.4	51.2	0.0	0.0
FTCH	Buy	3.4	1.4	13.6	2.0	1.9	33.4	44.4	0.0	0.0
FUTU	Buy	0.0	2.1	0.0	97.9	0.0	0.0	0.0	0.0	0.0
FUTU	Sell	5.0	2.4	21.8	0.7	0.0	9.2	45.6	4.1	11.2
GOTU	Buy	13.0	13.8	22.9	3.5	16.9	19.1	10.5	0.0	0.2
GOTU	Sell	4.6	0.0	9.2	85.8	0.0	0.4	0.0	0.0	0.0
IQ	Buy	10.7	18.3	15.0	4.7	9.4	15.5	26.5	0.0	0.0
RKT	Buy	24.0	2.6	43.1	1.7	28.6	0.0	0.0	0.0	0.0
RKT	Sell	30.0	1.6	32.6	8.8	0.0	23.1	3.8	0.0	0.0
TCBI	Buy	36.6	33.4	0.0	6.0	3.1	8.1	12.7	0.0	0.0
TME	Buy	16.2	7.1	24.3	3.8	3.8	9.1	35.6	0.0	0.0
VIAC	Buy	6.1	9.9	21.9	1.7	3.7	23.1	32.5	1.2	0.0
VIAC	Sell	0.0	31.3	23.5	17.5	0.0	0.0	27.7	0.0	0.0
VIPS	Buy	13.7	0.4	22.9	1.7	0.0	22.0	39.3	0.0	0.0

104. Professor Battalio will also present the results visually. As demonstrated below, in Figure 29, which illustrates results for DISCA, and Figure 30, which illustrates results for FUTU, Archegos used TWAP and VWAP disproportionately at the end of the trading day, including in the final ten minutes of trading.

Figure 29 - DISCA Algorithm Selection by Time of Day

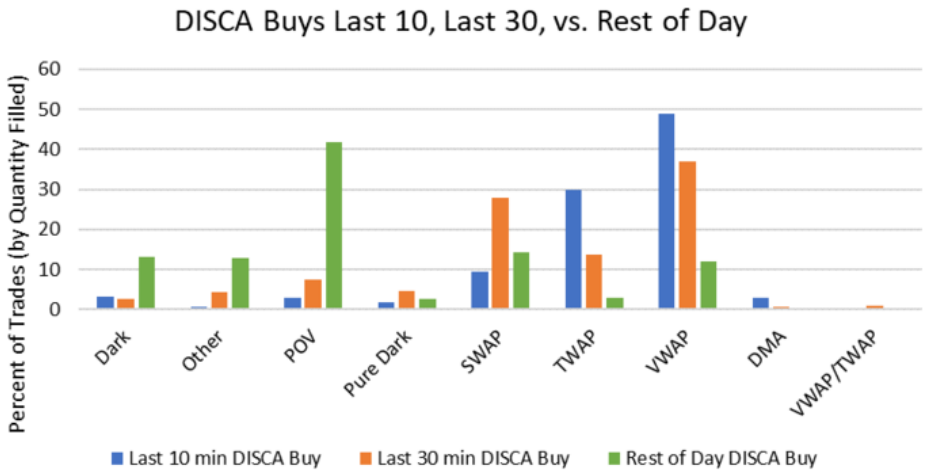
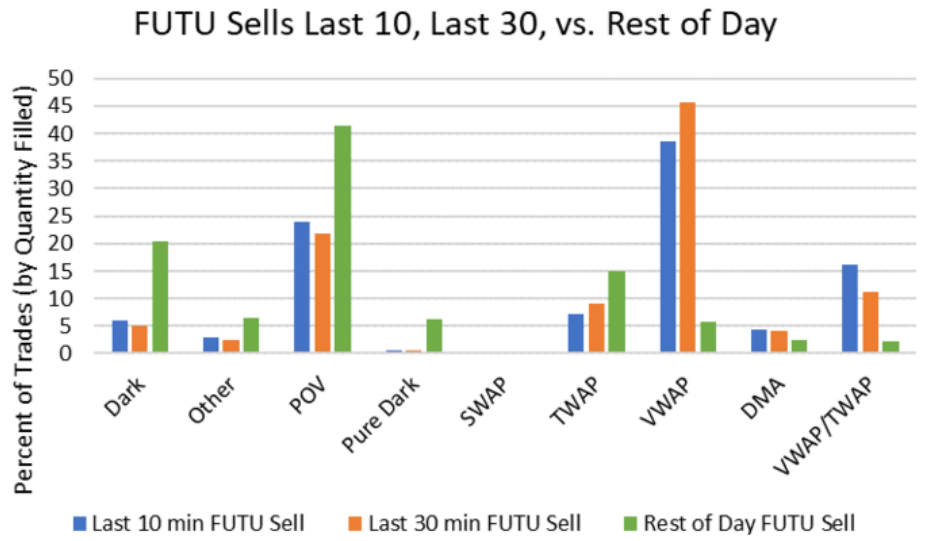


Figure 30 - FUTU Algorithm Selection by Time of Day



Additional graphs and results are included in the produced files and collected in the file "StrategyBreakdown_PercentOfParentOrders.pdf" and "StrategyBreakdown_PercentofTrades.pdf."

105. As described in the Initial Battalio Notice, Professor Battalio will identify multiple instances in which Archegos placed orders using multiple strategies on the same day, including multiple orders with different strategies at the same time, in order to further increase the quantity

purchased. These observations rest on the EMSX data described above, including the derivative intermediate table, "par_orders.fst," which Professor Battalio used to identify order instruction changes, including algorithm instructions.

106. Professor Battalio summarizes Archegos use of multiple algorithms on the same day. The table below shows the number of days in which Archegos uses a certain number of algorithms.

Table 21 - Frequency Count of Archegos Strategies Used on a Given Day, April 1, 2020 - March 23, 2021

Count	**1**	**2**	**3**	**4**	**5**	**6**	**7**
BIDU	44	44	31	10	2	0	0
DISCA	18	26	33	10	2	0	0
DISCK	6	9	16	16	9	1	0
FTCH	13	24	21	17	9	1	0
FUTU	52	24	33	28	15	7	1
GSX	37	46	43	22	9	1	0
IQ	50	45	29	14	1	0	0
RKT	24	31	19	4	1	0	0
TCBI	40	22	10	2	0	0	0
TME	23	60	41	15	2	0	0
VIAC	48	69	43	20	5	1	0
VIPS	19	47	25	7	4	0	0

4. Aggressive Order Sizes, Trade Volume, and Limit Changes

107. As described in the Initial Battalio Notice, Professor Battalio will present a comparative analysis to demonstrate that Archegos's active orders in the Top Archegos Securities were larger and more aggressive than active orders by other market participants. (The analysis also reflects Archegos's bidding at or above previous best bids.)

108. Professor Battalio's comparison builds off the trade mapping methodology identified above. Using the matching methodology noted above, Nasdaq order book data was matched with Archegos order and execution data to determine which orders came from Archegos and which orders came from other market participants. Similarly, TAQ data was matched with Archegos order and execution data to determine which trades came from Archegos. Finally, the TAQ data was combined with the NBBO data to compare orders to the national best bid. Order sizes and quantities are in shares and rounded to nearest integer. Due to data limitations, order statistics exclusively refer to trades that were executed at least in part. IOC is immediate or cancel orders. In the Nasdaq data, active trades are defined as the second order placed in a match (that is, the order that initiates a trade) and a passive trade is the existing trade it executes against. A small number of trades could not be typed as Active or Passive. In the TAQ data trades cannot be identified as active or passive.

109. In addition, Professor Battalio has calculated trade volume by time of day in 30-minute increments, both for Archegos, and market-wide trade volume, with the assistance of a program written in R. Archegos's trade volume derives from the EMSX order and execution data maintained by Bloomberg, while the market-wide trade volume derives from TAQ data.[40] The analysis covers April 1, 2020 through March 23, 2021. Professor Battalio will calculate the Archegos volume as a percentage of the total market volume in that 30-minute increment over the time period. For each security, this is limited to the days in which Archegos traded. This will be provided in table format and in graphical format for each of the Archegos Top Long and Top Short Positions. This was done using R code.

110. Tables 23 and 24 report summary statistics regarding Archegos's Nasdaq trading compared to other market participants, from October 1, 2020 to March 23, 2021.

Table 22 - Active Orders Compared

	Archegos Active Trades				Non-Archegos Active Trades			
Ticker	Median Trade Size	Avg. Trade Size	% of Trade > 1,000 shares	IOC % of Vol	Median Trade Size	Avg Trade Size	% of Trade > 1,000 shares	IOC % of vol
DISCA	300	2,502	20.0%	88.4%	100	271	2.8%	90.7%
DISCK	300	1,476	21.3%	92.8%	100	214	1.6%	88.8%
FUTU	300	2,573	25.8%	93.8%	82	233	3.1%	90.3%
IQ	300	3,368	24.9%	91.5%	100	451	6.4%	90.5%
TCBI	200	849	7.0%	86.9%	50	118	0.6%	92.7%
VIAC	200	2,711	21.3%	93.0%	100	326	3.7%	91.8%

[40] The analysis makes use of intermediate table, "volume_by_minute_taq2," produced through a program written in R and SQL. Each trade in the market wide TAQ data the time was truncated to the minute preceding the trade. So, for example, a trade that occurred at 10:05 and 37 seconds was assigned to the minute 10:05. For each minute's trades the sizes of each trade were summed up per ticker to calculate the volume by minute and ticker. The full output, which will be produced, is in the file, "volume_by_minute.rds."

Table 23 - Active vs. Passive Trading

Archegos Active Trades			Archegos Passive Trades	
	% of Volume	Median Trade Size	% of Volume	Median Trade Size
DISCA	72.7%	300	26.4%	100
DISCK	71.1%	300	28.4%	100
FUTU	60.1%	300	39.7%	100
IQ	65.6%	300	34.2%	100
TCBI	51.4%	200	48.6%	200
VIAC	74.3%	200	24.6%	100

111. Tables 25 and 26 report summary statistics regarding Archegos's market wide trading (as reflected in TAQ data) compared to other market participants, from April 1, 2020 to March 23, 2021.

Table 24 - Top Long Position Trades Above Previous Best

	Archegos Trades	**Non-Archegos Trades**
% of trades larger than the previous best ask size	95.9%	88.3%
% of trades executing at higher price than the previous best bid	66.2%	64.9%

Table 25 - Archegos Trade Sizes Compared to Market

Archegos Trades			**Non-Archegos Trades**	
Ticker	Median Trade Size	Avg. Trade Size	Median Trade Size	Avg. Trade Size
BIDU	100	101	37	92
DISCA	100	167	100	139
DISCK	100	146	100	134
FTCH	100	164	100	173
FUTU	100	228	50	107
GSX	100	166	100	181
IQ	100	249	100	218
RKT	100	287	100	205
TCBI	100	144	39	105
TME	100	278	100	339
VIAC	100	208	100	205
VIPS	100	207	100	270

112. Professor Battalio also computed Archegos's share of trade volume on each exchange for the Top Archegos Positions relative to other market participants. Table 27, below, reports the results.

Table 26 - Archegos Volume by Exchange

TAQ exchange code	TAQ exchange name	Archegos Volume	Non Archegos Volume	Archegos % of Volume
A	NYSE American	3,865,387	32,947,370	10.5%
B	NASDAQ OMX BX	19,597,791	164,472,714	10.6%
C	NYSE National	4,466,474	191,613,902	2.3%
D	FINRA Alternative Display Facility	573,640,328	7,307,786,389	7.3%
H	MIAX	204,188	10,952,865	1.8%
J	Cboe EDGA	31,269,062	283,980,502	9.9%
K	Cboe EDGX	77,425,853	1,074,865,942	6.7%
L	LTSE	2,645	10,879	19.6%
M	NYSE Chicago	322,113	65,633,650	0.5%
N	NYSE	94,232,348	4,669,818,219	2.0%
P	NYSE Arca	108,043,124	1,295,632,036	7.7%
Q	NASDAQ (in Tape C securities)	220,397,385	4,641,530,973	4.5%
T	NASDAQ (in Tape A, B securities)	119,178,579	1,173,493,826	9.2%
U	MEMX	5,031,229	49,038,367	9.3%
V	IEX	90,301,370	585,670,093	13.4%
X	NASDAQ OMX PSX	4,821,950	91,714,115	5.0%
Y	Cboe BYX	27,037,075	266,969,509	9.2%
Z	Cboe BZX	104,376,272	941,020,573	10.0%

113. Professor Battalio will also present graphs that show Archegos's trade volume as a percentage of market-wide volume by time of day. This is done from April 1, 2020 through March 23, 2021, along with 2020 and 2021 presented separately.[41] Figure 31 and 32, below, show Archegos's percent of trade volume in DISCA and VIAC, respectively, in 30 minutes segments of trading days. As reflected in the underlying data, and illustrated by these graphs, Archegos consistently achieved significant trade volume in its top positions, particularly at the end of the trading day.

[41] A collection of draft graphs will be produced.

Figure 31 - DISCA Trading - Archegos % of Volume

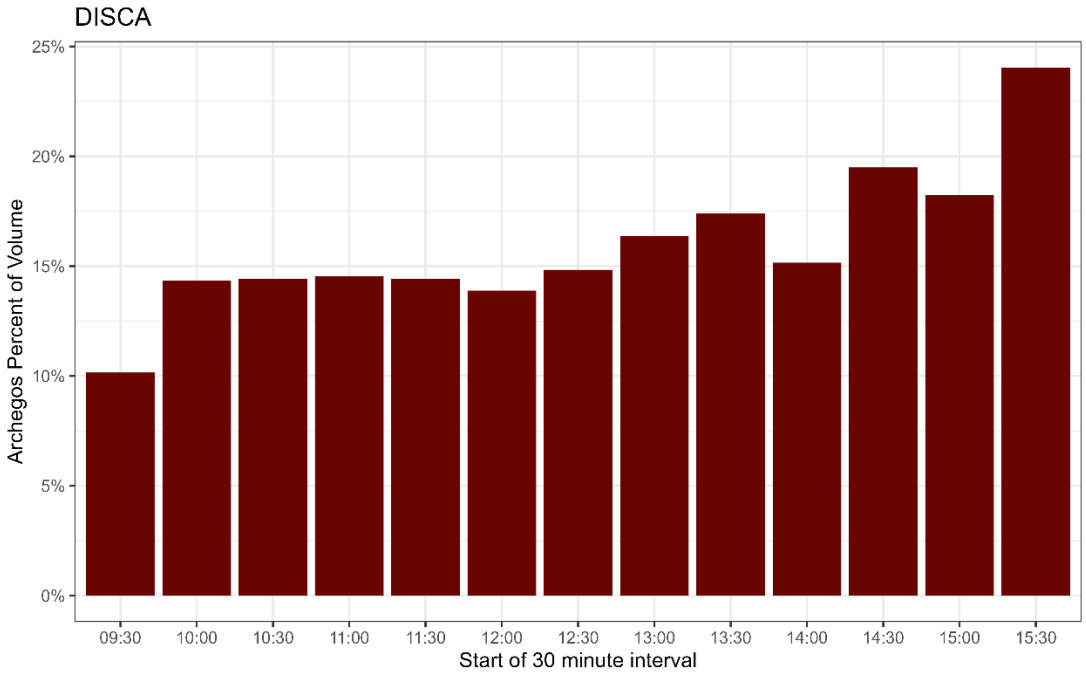
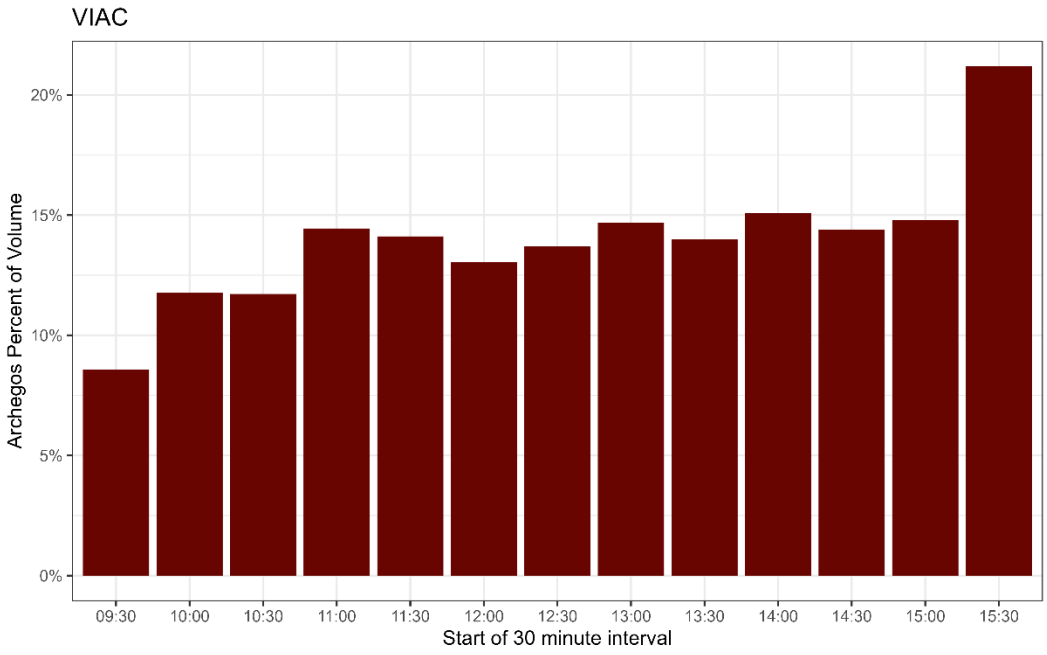


Figure 32 - VIAC Trading - Archegos % of Volume



114. Professor Battalio will present graphs and summary statistics regarding the size of Archegos parent orders. In the histograms below, the size of parent orders are depicted. These

histograms count changes to the parent order as if it were a new order and plot the adjusted quantity, the amount remaining on the updated order after accounting for the quantity previously filled. These parent order analyses cover trades between April 1, 2020 through and including Mar 23, 2021. Analysis was conducted using a program in R and relies on an intermediate data file called "par_orders.fst"[42]

[42] In addition the examples provided in this notice, other draft charts have been generated and will be produced.

Figure 33 - TME Parent Order Size Distribution

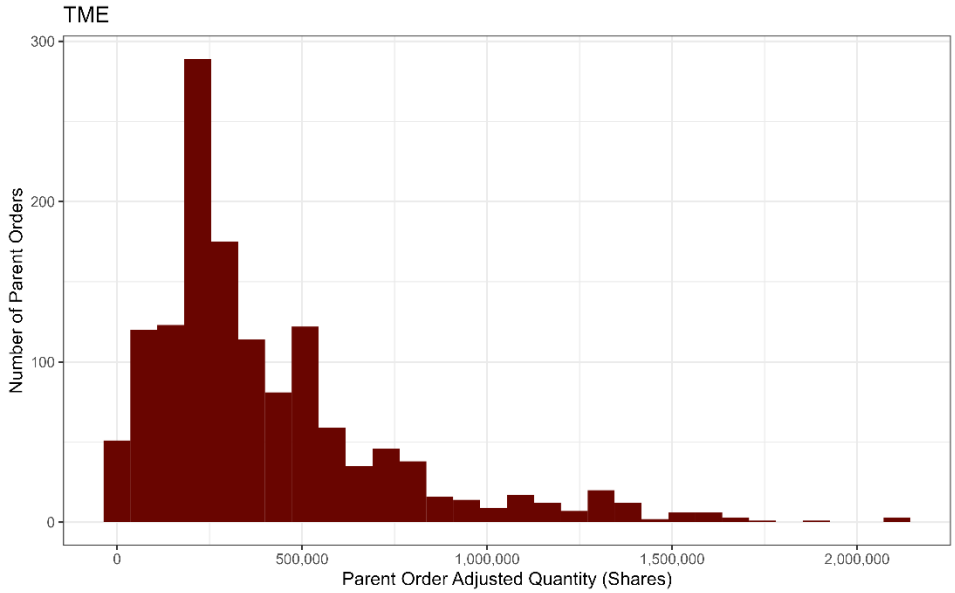
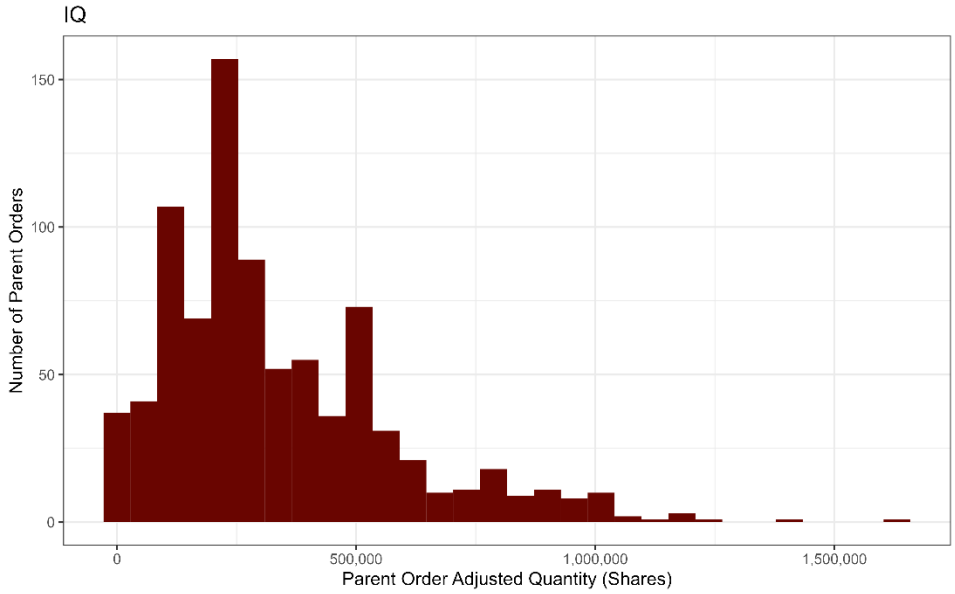


Figure 34 - IQ Parent Order Size Distribution



115. In the statistics below, the sizes of parent orders are compared with the average daily volume of each top long security. To determine the size of a parent order, the maximum value for each order's quantity over the course of the day is used (not the adjusted quantity). Updates to an order are not counted as if they were a new order. The average daily volume of each security was calculated using market-wide TAQ data.

Table 27 - Parent Order Size Statistics

PANEL A	Apr 1 – Aug 31, 2020	Sep 1 – Dec 31, 2020	Jan 1 – Mar 23, 2021
# of parent orders placed	1,448	1,874	2,973
# seeking 1% of ADV or more	1,202	1,549	2,004
# seeking 2% of ADV or more	867	1,179	1,448
# seeking 5% of ADV or more	360	437	534
# seeking 10% of ADV or more	76	99	149
# seeking 20% of ADV or more	12	15	22

PANEL B	Apr 1 – Aug 31, 2020	Sep 1 – Dec 31, 2020	Jan 1 – Mar 23, 2021
# of parent orders placed	26	24	346
# seeking 1% of ADV or more	16	13	79
# seeking 2% of ADV or more	5	8	35
# seeking 5% of ADV or more	0	1	8
# seeking 10% of ADV or more	0	0	2
# seeking 20% of ADV or more	0	0	1

116. Professor Battalio will also present regression results that show significant drivers of per percent active are strategy and parent order quantity size.

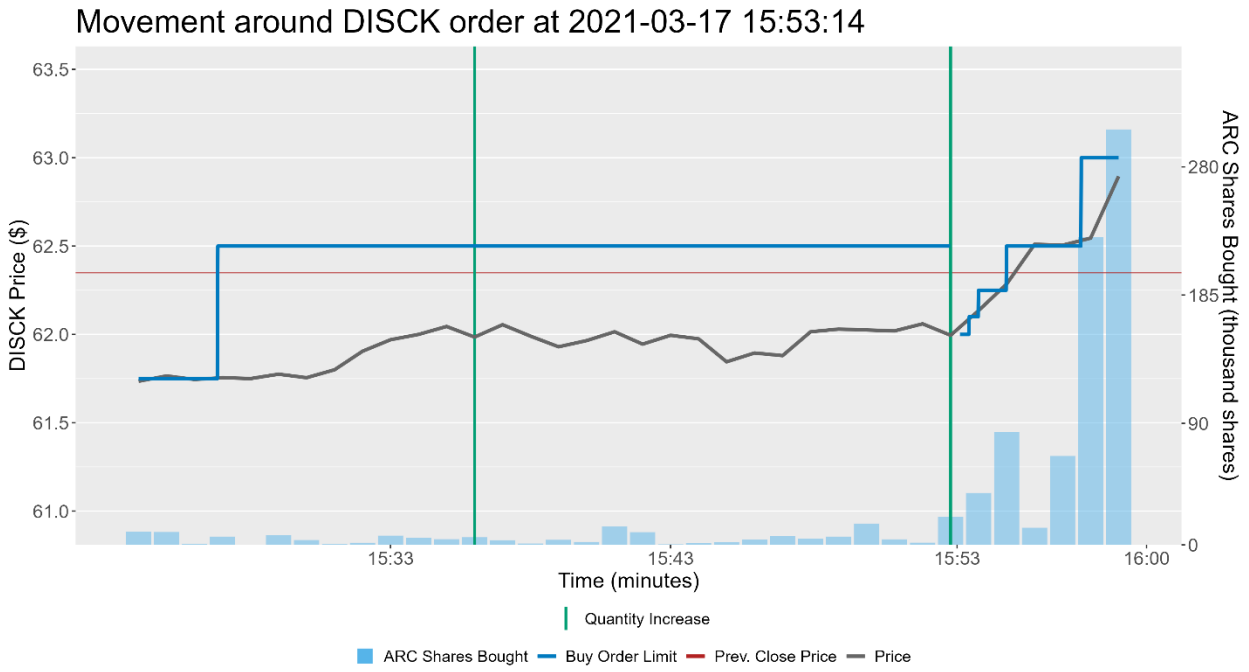
Table 28 - Probit regression for drivers of Archegos active child trades

Coefficient	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-0.40	0.00	-139.89	0.00
DISCA	0.09	0.00	35.98	0.00
DISCK	0.00	0.00	0.65	0.52
FTCH	0.24	0.00	94.40	0.00
FUTU	0.36	0.00	142.16	0.00
GSX	0.20	0.00	81.94	0.00
IQ	0.15	0.00	62.83	0.00
RKT	0.04	0.00	13.23	0.00
TCBI	0.31	0.01	54.77	0.00
TME	0.10	0.00	45.67	0.00
VIAC	0.15	0.00	73.04	0.00
VIACA	-0.40	0.09	-4.60	0.00
VIPS	0.20	0.00	83.24	0.00

Parent order quantity as a % of previous day's volume	0.01	0.00	36.80	0.00
Dark	0.04	0.00	16.32	0.00
DMA	-0.34	0.01	-44.30	0.00
Other	0.14	0.00	52.61	0.00
POV	0.21	0.00	89.82	0.00
SWAP	0.21	0.00	72.63	0.00
TWAP	0.34	0.00	110.26	0.00
VWAP	0.23	0.00	85.54	0.00
VWAP/TWAP	0.43	0.01	38.50	0.00

117. Professor Battalio will present graphs that plot order changes against market prices and execution activity.[43] Figures 35, 36, and 37 show examples of order changes where Archegos increased their parent order quantity, which resulted in increases in child trade executed volume, and then subsequent stock price increases. Archegos volume and orders data is from Archegos EMSX records maintained by Bloomberg. Security prices derive from NBBO data.

Figure 35 - DISCK Order Change on March 17, 2021



[43] Example graphs will be produced.

Figure 36 - VIAC Order Change on January 4, 2021

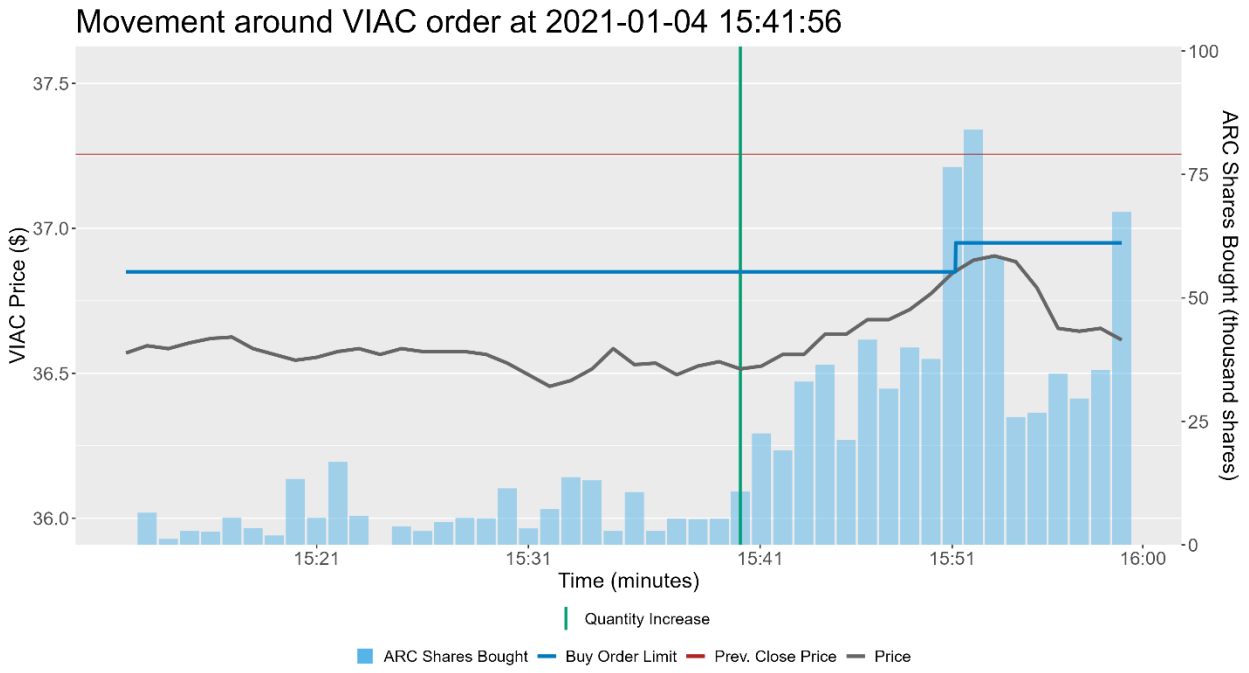
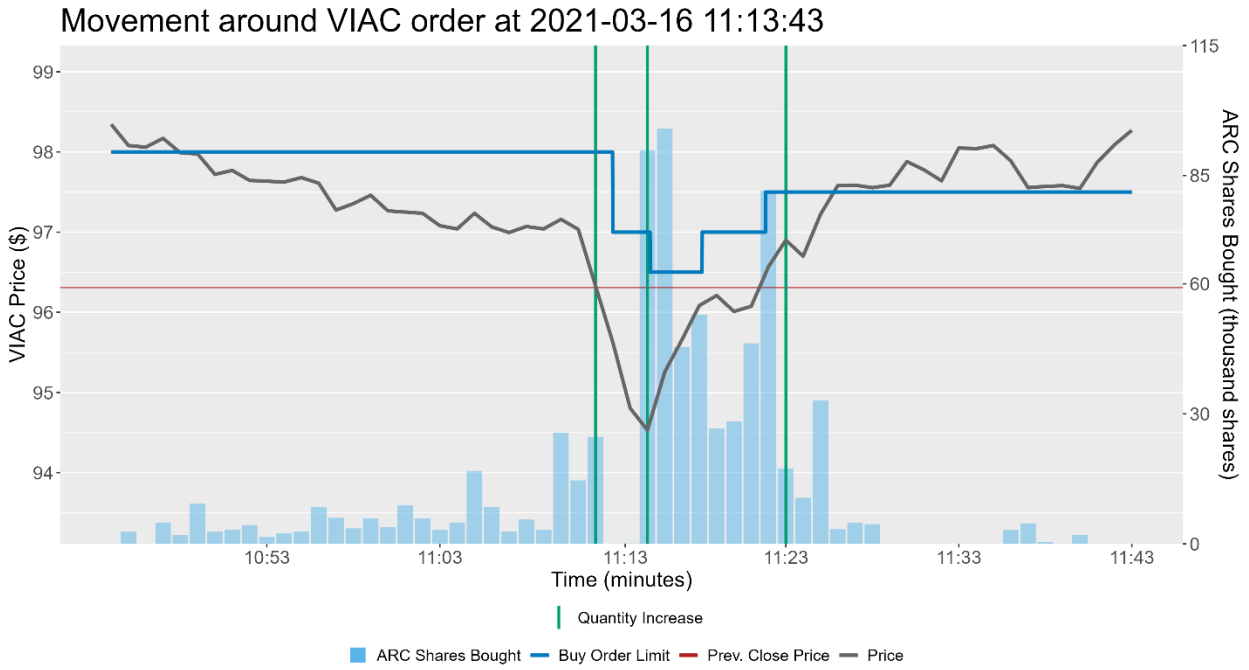


Figure 37 - VIAC Order Change on March 16, 2021



5. Archegos Trading Incurred Implementation Shortfall

118. As described in the Initial Battalio Notice, Professor Battalio will demonstrate that Archegos acquired its positions in the Archegos Top Long Positions inefficiently, as measured by its implementation shortfall. Implementation shortfall refers to the deviation of execution prices from the prevailing midpoint price at the time a buy or sell parent order was placed.[44]

i. Scope & Sources

119. Professor Battalio computed implementation shortfall for Archegos's top positions between April 1, 2020 and March 23, 2021. The analysis primarily relies on (a) Archegos EMSX data obtained from Bloomberg[45]; (b) TAQ NBBO data for price; (c) TAQ market wide trade data for daily volumes; and (d) the intermediate table, "par_orders.fst," for parent orders.

ii. Methodology

120. Professor Battalio calculated implementation shortfall for a given (updated) parent order using the prevailing mid-point at the time of an original or updated time-stamp: the volume weighted average price of that original or updated parent order's fills, minus the prevailing midpoint. Weights are determined by a given ticker's parent order quantity divided by previous day's volume. The analysis was completed using a computer program written in R.[46]

iii. Results

121. Professor Battalio's analysis confirms that Archegos's orders, in fact, resulted in implementation shortfall. Table 30, below, sets out summary results for the period April 1, 2021 to March 23 2021.[47]

Table 29 - Mean Implementation Shortfall from April 1, 2020 to March 23, 2021

Ticker	Unweighted	Weighted
BIDU	0.15	0.19
DISCA	0.13	0.16
DISCK	0.14	0.20
FTCH	0.24	0.24
FUTU	-0.19	-0.16
GSX	0.28	0.30
IQ	0.40	0.51

[44] *See, for example*, Perold, Andre F. "The implementation shortfall: Paper versus reality." *Journal of Portfolio Management* 14, no. 3 (1988): 4.
[45] Bloomberg - FOIA Confidential Treatment Requested - 21mag9335.csv
[46] The code used to complete this analysis is in the file, "po_analyses.R."
[47] "Weighted" means the value is weighted by a given ticker's fill quantity as a percentage of previous day's volume. Short positions highlighted.

RKT	-0.11	-0.12
TCBI	0.26	0.39
TME	0.23	0.25
VIAC	0.14	0.17
VIPS	0.42	0.49

122. Table 31, below, sets out summary results for the period January 1, 2021 to March 23 2021.[48]

Table 30 - Mean Implementation Shortfall from January 1, 2021 to March 23, 2021

Ticker	Unweighted	Weighted
BIDU	0.18	0.38
DISCA	0.13	0.21
DISCK	0.13	0.20
FTCH	0.25	0.40
FUTU	-0.16	-0.32
GSX	0.33	0.30
IQ	0.45	0.65
RKT	0.03	0.06
TCBI	0.14	0.31
TME	0.27	0.43
VIAC	0.18	0.25
VIPS	0.48	0.64

123. Table 32 and Figure 33 report results where sell parent orders are re-signed by -1 for the period April 1, 2020 to March 23, 2021.

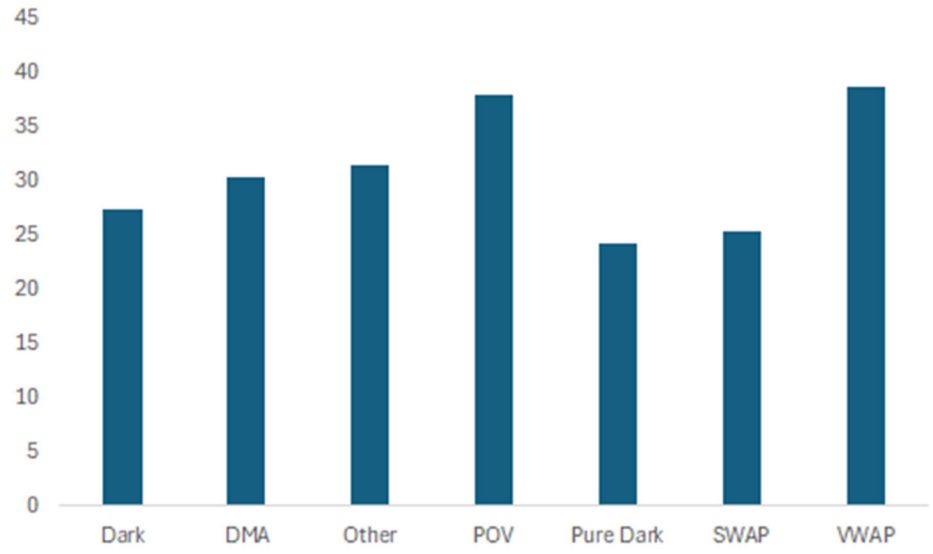
Table 31 - Mean Re-Signed Archegos Implementation Shortfall By Ticker and Strategy Code

ticker	Dark	DMA	Other	POV	Pure Dark	SWAP	VWAP
BIDU	11.8	-	16.1	25.6	-	-	31.2
DISCA	17.3	-	25.2	12.9	-	-	-
DISCK	10.7	-	-	17.5	-	-	-
FTCH	18.2	-	-	43.4	-	-	-
FUTU	21.3	30.3	51.7	41.3	61.7	-	43.9
GSX	35.3	-	24.5	32.6	-9.0	25.3	-
IQ	43.3	-	53.6	67.0	-	-	-
RKT	29.1	-	-	53.6	33.7	-	-
TCBI	27.0	-	-	-	-	-	-

[48] "Weighted" means the value is weighted by a given ticker's fill quantity as a percentage of previous day's volume. Short positions highlighted.

TME	37.3	-	23.8	45.3	-	-	-
VIAC	20.8	-	25.7	16.7	10.2	-	41.3
VIPS	55.9	-	-	62.3	-	-	-
Average	**27.3**	**30.3**	**31.5**	**38.0**	**24.2**	**25.3**	**38.8**

Figure 38 - Average Weighted Mean Re-Signed Archegos Implementation Shortfall Across Top Archegos Securities by Strategy



124. Professor Battalio has also analyzed the drivers of Archegos's implementation shortfall, focusing on parent order size and algorithm strategy, through use of regression analysis. That analysis demonstrates that parent order size and algorithm strategy are significant drivers of implementation shortfall. The summary results are set forth in Table 33 and reflect analysis wherein sell parent orders are re-signed by -1, with ticker-level fixed effects, the base level is BIDU with strategy code of Pure Dark. The coefficients for the strategies reflect the excess implementation shortfall of the strategy relative to a Pure Dark strategy.

Table 32 - Drivers of Archegos's Implementation Shortfall, April 1, 2020 to March 23, 2021

Coefficient	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-0.20	0.03	-6.03	0.00
DISCA	-0.05	0.03	-1.53	0.13
DISCK	-0.05	0.03	-1.43	0.15
FTCH	0.04	0.03	1.31	0.19
FUTU	0.18	0.03	5.75	0.00
GSX	-0.05	0.03	-1.78	0.08
IQ	0.19	0.03	5.47	0.00
RKT	0.12	0.04	3.22	0.00
TCBI	0.02	0.05	0.43	0.67
TME	0.06	0.03	1.96	0.05
VIAC	-0.01	0.03	-0.40	0.69
VIPS	0.24	0.04	6.67	0.00
Percent of parent order filled	0.23	0.02	12.14	0.00
Parent order quantity, adjusted by previous day's volume	0.03	0.00	11.86	0.00
Interaction var. for centered % fill and centered quantity	0.04	0.00	9.25	0.00
Dark	0.09	0.02	3.75	0.00
DMA	0.04	0.05	0.70	0.49
Other	0.13	0.03	5.03	0.00
POV	0.14	0.02	6.37	0.00
SWAP	0.14	0.04	3.84	0.00
TWAP	0.30	0.04	7.45	0.00
VWAP	0.32	0.05	6.09	0.00
VWAP/TWAP	0.56	0.13	4.47	0.00
Bid-Ask Spread	0.25	0.07	3.69	0.00
First 30 Minutes	0.21	0.02	10.30	0.00
Last 30 Minutes	-0.08	0.02	-4.07	0.00
VWAP and Last 30 Minutes	-0.08	0.06	-1.37	0.17

125. Professor Battalio will opine that the implementation shortfall analysis shows that Archegos built its positions inefficiently. Professor Battalio will explain generally that implementation shortfall is a measure of price-impact trading costs. In a perfectly efficient world, shortfall would be zero because trades would occur at the midpoint. Implementation shortfall quantifies how far from perfect the trades have been achieved. Professor Battalio will note that the implementation shortfall figures incurred by Archegos exceed that of professional traders studied in academic literature and that they reflect significant trading costs. Based on this analysis, Professor Battalio will opine that Archegos's order submission strategy was not consistent with a strategy to minimize price-impact costs.

126. Based on the implementation shortfall analysis and the algorithm analysis, Professor Battalio will further opine that Archegos's use of aggressive algorithms and use of multiple simultaneous algorithms made it more likely that those orders would be filled at worse prices (that is, higher prices when Archegos was purchasing and lower prices when Archegos was selling) than had Archegos used different order-handling instructions.

G. Conclusions

127. Based on Archegos's order and execution records and the analyses described above, Professor Battalio will opine that Archegos's order submission strategies were consistent with a strategy to influence market prices in the Archegos Top Securities and inconsistent with a strategy to build concentrated positions in the Top Archegos Securities at the best available prices.

128. Based on the analyses described above, Professor Battalio will further opine that the prices of the Archegos Top Securities on Nasdaq markets and the American stock market as a whole on multiple days between March 2020 and March 2021 and consistently between October 2020 and March 2021 resulted, in part, from Archegos's order and trading activity.

129. Professor Battalio will further opine that, by March 23, 2021, the prevailing prices of the Archegos Top Long Positions did not reflect the ordinary operation of supply and demand but rather reflected accumulated price pressure caused by Archegos's activity. Put differently, Professor Battalio will opine that the prices of the Archegos Top Long Positions would not have reached or maintained the prices they held in March 2021 without Archegos's activity.

H. Approval and Signature

I hereby approve the supplemental disclosure of my qualifications, anticipated opinions, and bases for such opinions, as set forth above.

Professor Robert Battalio